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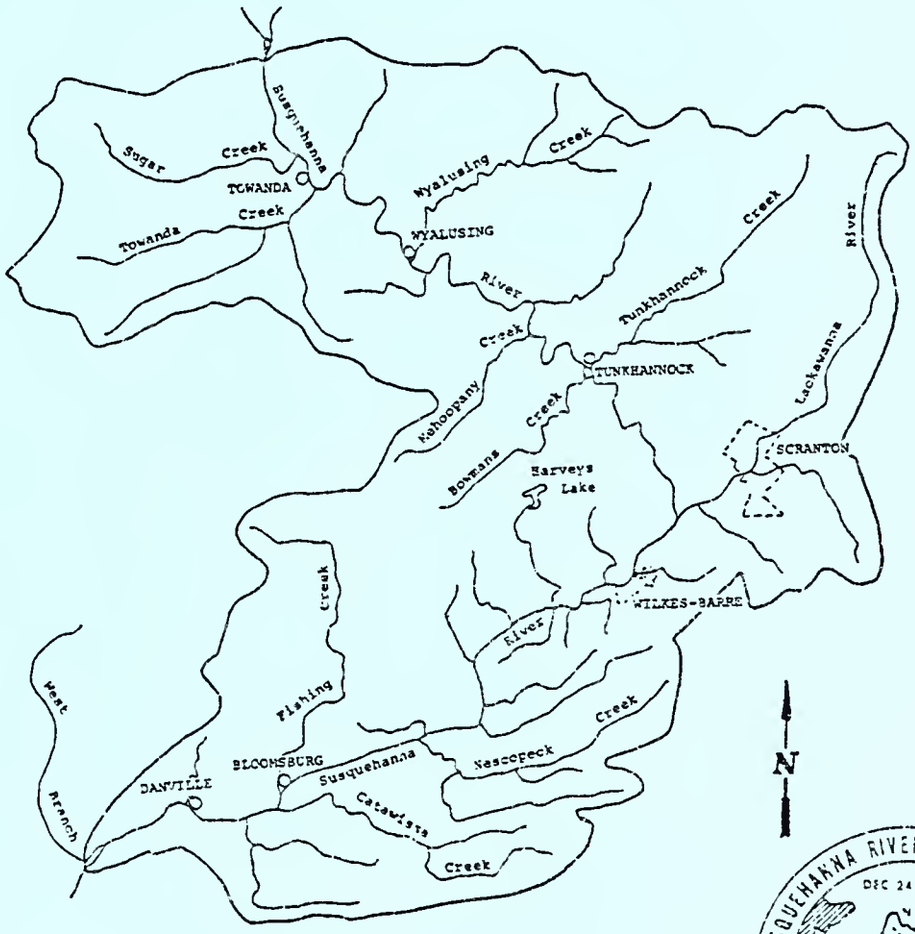
UPPER SUSQUEHANNA SUBBASIN LOW FLOW MANAGEMENT FRAMEWORK PLAN



SRBC
SUSQUEHANNA RIVER
BASIN COMMISSION

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The Susquehanna River Basin Commission was created as an independent agency by a Federal-Interstate Compact* among the States of Maryland, New York, Commonwealth of Pennsylvania and the Federal Government. In creating the Commission, the Congress and State Legislatures formally recognized the water resources of the Susquehanna River basin as a regional asset vested with local, State and National interests for which all the parties share responsibility. As the single Federal-Interstate water resources agency with basinwide authority, the Commission's goal is to effect coordinated planning, conservation, management, utilization, development and control of basin water resources among the government and private sectors.

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* Statutory Citations: Federal - Pub. L. 91-575, 84 Stat. 1509 (December, 1970); Maryland - Natural Resources Sec. 8-301 (Michie 1974); New York - ECL Sec. 21-1301 (McKinney 1973); and Pennsylvania - 32 P.S. 820.1 (Supp. 1976).

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UPPER SUSQUEHANNA SUBBASIN

LOW FLOW MANAGEMENT FRAMEWORK PLAN

Prepared by:

David W. Heicher
Program Specialist

Gilbert H. Hirschel
Water Resource Management Planning Specialist

Susquehanna River Basin Commission
1721 North Front Street
Harrisburg, PA 17102

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Heicher, David W.
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I. INTRODUCTION

This report is the fifth in a series of low flow management framework plans prepared by the Susquehanna River Basin Commission (SRBC). The objectives of these reports are to identify existing and potential water supply problems, provide guidance for programs of the SRBC and other resource agencies, and provide the foundation for future water supply planning. Framework planning reports were previously prepared for the Chemung, Eastern New York, West Branch Susquehanna River, and Juniata Subbasins. Planning efforts are currently underway for the Lower Susquehanna Subbasin (Figure 1). Ultimately, framework plans will be developed for all six subbasins and will be integrated to facilitate management of the available water resource during periods of low flows in the Susquehanna River Basin.

The SRBC's Comprehensive Plan states that the objective of the water supply program is "fulfillment of immediate and projected long-range demands of the people of the basin for domestic, municipal, agricultural, and industrial water supply, including use for cooling and irrigation." Several relevant goals of the water supply program are listed as follows:

1. Coordination of water supply, water quality, and land use planning development programs.

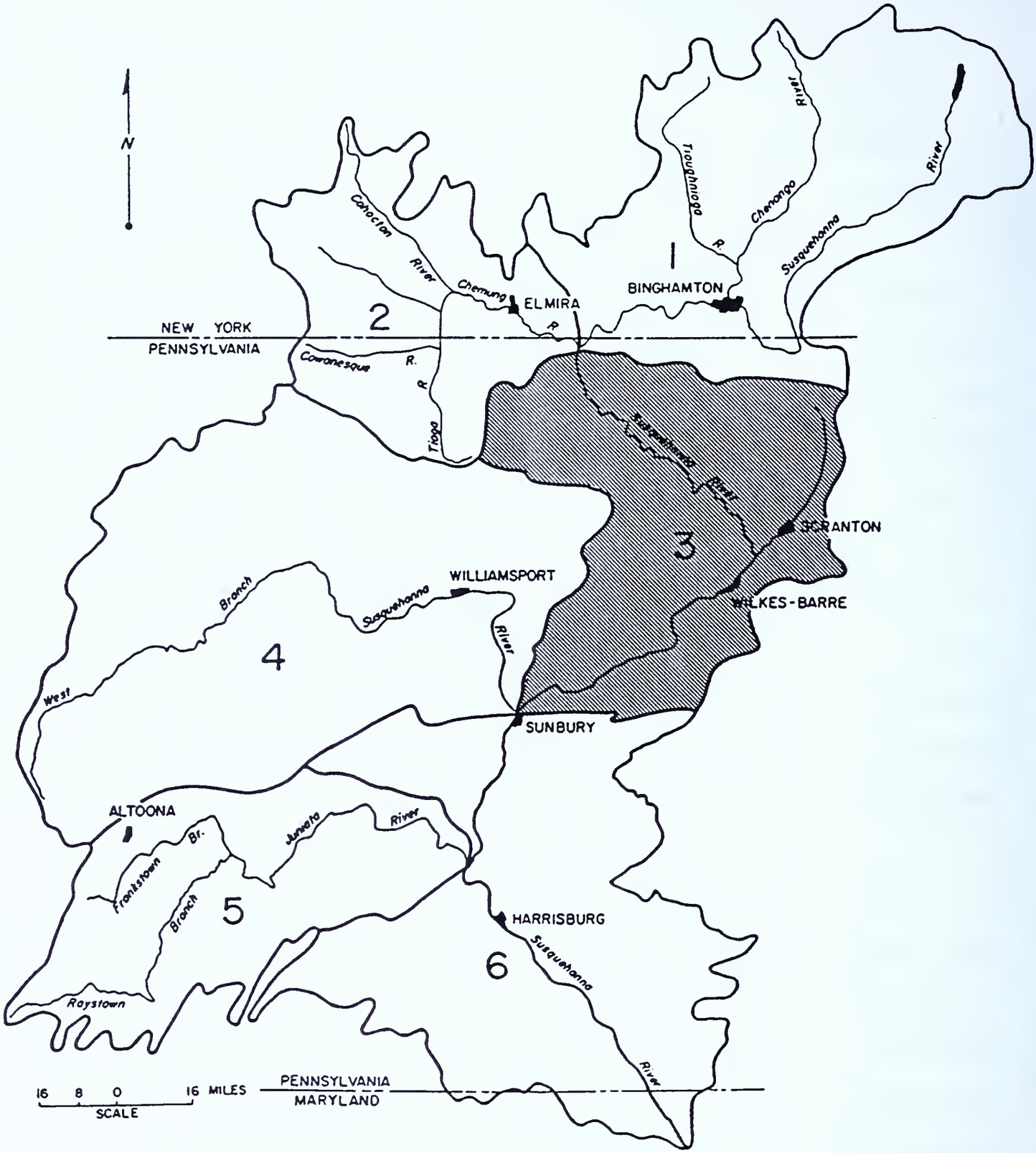


FIGURE 1

THE SUSQUEHANNA RIVER BASIN COMMISSION

UNITED STATES·NEW YORK·PENNSYLVANIA·MARYLAND

HYDROLOGIC SUBBASINS

LEGEND

Subbasin 1 – Eastern New York
Subbasin 2 – Chemung
Subbasin 3 – Upper Susquehanna
Subbasin 4 – West Branch Susquehanna
Subbasin 5 – Juniata
Subbasin 6 – Lower Susquehanna

2. Development of basinwide and regional plans for the conservation, development, management, and use of the surface and ground waters of the basin for domestic, municipal, industrial, and agricultural use.

3. Establishment of an equitable system for the allocation of water for various uses, including protection of instream flows, and protection of the receiving waters of the Chesapeake Bay.

4. Development of contingency management plans for immediate implementation during water-short periods.

5. Prevention of reduction of low flows into the Chesapeake Bay, including development of policies for reducing future consumptive losses.

The SRBC low flow management framework plans will facilitate development of an equitable system for water management during water-short periods. Surface and ground-water availability are examined with particular emphasis on stream low flow frequency and duration. Water use and historical low flows are analyzed to identify existing and future water supply problems within specific geographic areas. Potential management actions are identified for further consideration. Data gaps are identified and discussed. The plans are intended to be dynamic and may be modified as water supply needs change.

The SRBC framework plans use the 7-day 10-year low flow (Q7-10) value as an indicator to identify historical low flow periods, and to determine potential water supply deficits during a repeat of the most severe historical low flow period. The Q7-10 value is used as a planning tool for comparison purposes. No claim is made that maintenance of the Q7-10 value fulfills instream flow requirements within the subbasin, or that the Q7-10 value must be maintained.

II. PHYSICAL CHARACTERISTICS OF THE UPPER SUSQUEHANNA SUBBASIN

A. AREA, CLIMATE, PRECIPITATION, AND RUNOFF

The Upper Susquehanna Subbasin covers an area of about 3,755 square miles in northeastern Pennsylvania. It is nearly one-seventh of the area of the Susquehanna River Basin, which covers about 27,510 square miles in Pennsylvania, New York, and Maryland.

The Upper Susquehanna Subbasin has a climate that is influenced primarily by continental weather systems originating to the west of Pennsylvania (Pa. DER, 1978 and 1979). Major systems moving northward along the Atlantic coast from the Gulf of Mexico act as modifying climatic factors and periodically bring moderate to heavy precipitation to the area.

Air temperatures vary widely throughout the subbasin due to the effects of mountainous topography. The mean annual freeze-free period is between 135 and 165 days, depending on the location (Pa. DER, 1978 and 1979). Temperatures have been recorded greater than 102°F. and lower than -20°F. The mean summer temperature is about 70°F. and the mean winter temperature is about 27°F.

The mean annual precipitation averaged over the entire subbasin is about 39 inches (Taylor, 1984). Lower amounts occur along the Susquehanna and Lackawanna River valleys, and in the

northwestern part of the subbasin. Mean annual precipitation is greatest in the southeastern part of the subbasin.

Runoff is generally greatest in late winter and early spring, and is generally lowest in late summer and early fall. Taylor (1984) states that total runoff averages about 21 percent of annual precipitation.

B. GENERAL DESCRIPTION OF THE SUBBASIN'S WATER RESOURCES

1. Surface Water Bodies

The Upper Susquehanna Subbasin begins at the confluence of the Susquehanna River and the Chemung River in northern Bradford County, Pennsylvania (Figure 2). From the upstream end of the subbasin, the Susquehanna River flows generally southeast through mountainous terrain until meeting the Lackawanna River near West Pittston in Luzerne County, Pa. The river then bends towards the southwest and continues in that general direction until meeting the West Branch Susquehanna River at Northumberland, Pa.

Major tributaries of the Susquehanna River, with their respective drainage areas given in square miles, include Sugar Creek (190), Towanda Creek (277), Wysox Creek (102), Wyalusing Creek (220), Meshoppen Creek (114), Mehoopany Creek (123), Tunkhannock Creek (413), Bowman Creek (120), the Lackawanna River (348), Nescopeck Creek (174), Fishing Creek (385), and Catawissa Creek (153). No water from the Upper Susquehanna Subbasin is diverted out of the Susquehanna River Basin. Some water is

FIGURE 2

TRIBUTARIES, STREAM GAGING STATIONS, AND SUBBASIN SECTIONS OF THE UPPER SUSQUEHANNA SUBBASIN

▲ Existing Station (1987)
Ⓐ Discontinued Station
1 Subbasin Section Number

Source : U.S. Geological Survey, 1970 - 1987

Note: Station numbers are abbreviated. First two digits and last two digits (if zeros) are omitted. (Ex. - Station number 01531500 is shown as 5315.)

withdrawn from the Delaware River Basin by the City of Hazleton and diverted to the subbasin in the form of treated sewage effluent.

Natural lakes were formed after the retreat of the Wisconsin Age glaciers, which extended over much of the area that is now the Upper Susquehanna Subbasin. The Pa. DER (1970) identified a total of 30 natural lakes in the subbasin. The average size of these lakes is relatively small, with the largest covering an area of 112 acres. Many small water supply and recreational reservoirs are also scattered throughout the area.

The Pa. DER manages three recreational impoundments in the subbasin (Pa. DER, 1978). Lake Jean is located on Kitchen Creek at Ricketts Glen State Park in Sullivan and Luzerne Counties. The normal pool of the lake covers 245 acres and has a volume of 1,399 acre feet.

Lackawanna Lake and Frances Slocum Lake are managed by the Pa. DER for flood control, as well as recreation. Lackawanna Lake is located on the South Branch Tunkhannock Creek at Lackawanna State Park in Lackawanna County. Under normal conditions, Lackawanna Lake covers 202 acres and has a volume of 2,400 acre feet. Frances Slocum Lake is located on Abrahams Creek in Frances Slocum State Park, Luzerne County. The lake normally covers 165 acres and has a volume of 1,550 acre feet.

Two U.S. Army Corps of Engineers flood control reservoirs are located in the subbasin. Stillwater Reservoir is located on the Lackawanna River about 30 miles northeast of Scranton, Lackawanna County. The dam became operational in 1960. The primary purpose of Stillwater Reservoir is flood control, although water supply is a secondary use. Since the reservoir is used as a domestic water supply, no recreational facilities have been developed.

Aylesworth Creek Lake is located in Archbald Borough, Lackawanna County, on Aylesworth Creek about 1 mile upstream of the point where Aylesworth Creek meets the Lackawanna River. The dam was constructed for flood control and became operational in 1970. Land is leased to the Aylesworth Creek Park Authority, a volunteer organization that provides recreational facilities for picnicking, swimming, fishing, hiking, and other outdoor activities.

Pool areas and volumes of Stillwater Reservoir and Aylesworth Creek Lake are included in Table 1.

2. Stream Flows

The locations of existing and recently discontinued U.S. Geological Survey (USGS) stream gaging stations in the Upper Susquehanna Subbasin are shown on Figure 2. Table 2 lists these stations, their upstream drainage areas, average flows, and record low flows with their dates of occurrence. The period of record for stream flow data at each site is also listed.

TABLE 1

POOL AREAS & VOLUMES OF MAJOR FLOOD CONTROL PROJECTS IN THE UPPER SUSQUEHANNA SUBBASIN

	Stillwater Reservoir	Aylesworth Creek Lake
Normal Conservation Pool Area (Acres)	85	7
Normal Conservation Pool Capacity (Acre-Feet)	343	64
Flood Pool Area (Acres)[1]	423	87
Flood Pool Capacity[1] (Acre-Feet)	12,000	1,764

Source: U.S. Army Corps of Engineers (1984a and 1985).

[1] To top of spillway.

TABLE 2

STREAM GAGING STATIONS IN THE UPPER SUSQUEHANNA SUBBASIN

Site No.	Site Location	Upstream Drainage Area (mi^2)	Avg. Flow (cfs)	Record Avg. Daily Low Flow (cfs)	Date	Years of Record
01531500	Susquehanna R. at Towanda, Pa.	7,797	10,540	340	09-23-64	Oct.'13-Present
01532000	Towanda Crk. nr. Monroeton, Pa.	215	286	0.7	09-21-32	Feb.'14-Present
01532850	Middle Br. Wyalusing Crk. nr. Birchardville, Pa.	5.67	10.3	0.1	Many days Jul.-Sep. 1966	Aug.'65-Sep.'79**
01533400	Susquehanna R. at Meshoppen, Pa.	8,720	11,750	710	07-16-88	Oct.'76-Present
01533800	Butler Crk. at Gibson, Pa.	7.38	14.4	0.2	08-13-76	Oct.'73-Sep.'79***
01533950	S. Br. Tunkhannock Crk. nr. Montdale, Pa.	12.6	17.3	0.1	08-07-65, 08-08-65, & 11-22-66 thru 11-25-66	Aug.'60-Sep.'78
01534000	Tunkhannock Crk. nr. Tunkhannock, Pa.	383	539	6.9	09-24-64	Feb.'14-Present
01534300	Lackawanna R. nr. Forest City, Pa.	38.8	71.6	0.0	07-21-78 & 07-22-78	Oct.'58-Present
01534500	Lackawanna R. at Archbald, Pa.	108	203	13	11-11-64	Oct.'39-Present
01536000	Lackawanna R. at Old Forge, Pa.	332	491	26	07-16-62	Oct.'38-Present
01536500	Susquehanna R. at Wilkes-Barre, Pa.	9,960	13,330	530	09-27-64	Apr. 1899-Pres.
01537000	Toby Crk. at Luzerne, Pa.	32.4	45.5	0.5	09-20-46 & 10-08-46	Aug.'41-Present
01537500	Solomon Crk. at Wilkes-Barre, Pa.	15.7	18.8	0.0	09-04-83 thru 09-13-83 & 09-15-83 thru 09-20-83	Mar.'40-Present

Site No.	Site Location	Upstream Drainage Area (mi^2)	Avg. Flow (cfs)	Record Avg. Daily Low Flow (cfs)	Date	Years of Record
01538000	Wapwallopen Crk. nr. Wapwallopen, Pa.	43.8	64.7	1.5	08-31-53 & 08-05-55	Oct.'19-Present
01539000	Fishing Crk. nr. Bloomsburg, Pa.	274	478	8	09-12-64 & 09-13-64	Jun.'38-Present
01540200	Trexler Run nr. Ringtown, Pa.	1.77	2.25		Many days Sep. '64 & Jul.&Aug.'65	Aug.'63-Mar.'81
01540500	Susquehanna R. at Danville, Pa.	11,220	15,270	500	09-24-64, 09-25-64, & 09-27-64	Mar. 1899-Pres.

* Due to shutoff at Stillwater Dam.
** Occasional measurements & annual maximum also are available for 1960-1965.
*** Occasional measurements & annual maximum also are available for 1963-1973.

Source: U.S. Geological Survey (USGS) computer database & U.S. Geological Survey (1970-1987) annual reports.

Stream flow data for selected gaging station locations were obtained from the USGS WATSTORE data base. Statistical analyses of these data were made using the WATSTORE statistical programs.

Table 3 summarizes the occurrence of flows at or below the Q7-10 value at key gages in the Upper Susquehanna Subbasin. The table shows calculated Q7-10 values and compares the period of record examined with the number of years that flows less than or equal to these values occurred. For example, the table indicates that the period October 1913-September 1987 was examined for gaging station number 01531500 on the Susquehanna River at Towanda, Pa. At least one average daily flow of 577.8 cubic feet per second (cfs) (the Q7-10 value) or less was recorded in 10 of those years.

The Q7-10 value is significant because it is the criterion adopted by the SRBC for consumptive use make-up. Section 803.61 (c)(1)(i) of the SRBC Regulations and Procedures for Review of Projects states that "Compensation in an amount equal to the project's total consumptive use shall be required when the stream flow at the point of taking equals or is anticipated to equal the low flow criterion which is the 7-day 10-year low flow plus the project's total consumptive use and dedicated augmentation." The Commission also has the right to apply a higher low flow criterion for a particular stream reach when necessary for the purposes of protection of public health, stream quality control, economic development, protection of fisheries, recreation, dilution and abatement of pollution, the prevention of undue

TABLE 3

OCCURRENCE OF 7-DAY 10-YEAR LOW FLOW
VALUE AT KEY GAGES

USGS Station No.	Stream & Location	Q7-10 (cfs)	Gage Record Examined	No. Years Occurred
01531500	Susquehanna R. at Towanda, Pa.	577.8	10/13-09/87	10
01532000	Towanda Crk. nr. Monroeton, Pa.	2.8	02/14-09/87	8
01534000	Tunkhannock Crk. nr. Tunkhannock, Pa.	17.1	02/14-01/90	10
01536000	Lackawanna R. at Old Forge, Pa.	39.0	10/38-09/87	8
01536500	Susquehanna R. at Wilkes-Barre, Pa.	816.2	04/99-04/88	12
01540500	Susquehanna R. at Danville, Pa.	996.4	04/05-09/87	13

Source: U.S. Geological Survey Computer Database (WATSTORE).

Note: The Q7-10 values cited above are calculated values that were used to assess storage requirements discussed in Section IX of this report. These values are tabulated to the nearest 0.1 cfs in order to make comparisons of storage needs uniform regardless of watershed size.

salinity, protection of the Chesapeake Bay, and other purposes as determined by the Commission. Also, Section 803.61 (c)(1)(ii) of the SRBC regulations states that compensation for the consumptive use of ground water shall be required when the stream flow is less than the applicable low flow criterion. For the purpose of implementing the regulation, the Commission identifies the appropriate stream gaging station for determining the applicable low flow.

The effective date of the SRBC consumptive use make-up regulation is January 23, 1971. Consumptive uses occurring prior to this date are "grandfathered" (exempted) for the purposes of the regulation. Consumptive uses not exceeding an average of 20,000 gallons per day for any consecutive thirty-day period from surface or ground waters are generally exempt from make-up requirements.

3. Ground Water

The Upper Susquehanna Subbasin has abundant ground-water resources. A description of the hydrogeology of the region is provided by Taylor (1984). In general, aquifers in the subbasin consist of broadly folded and faulted sedimentary rocks in the south, flat-lying sedimentary rocks in the north, and unconsolidated sand and gravel along major streams. Wells in most of the aquifers yield adequate quantities of water for domestic use. However, investigations using appropriate geologic

and topographic criteria must often be used to locate large ground-water supplies.

The greatest amount of ground-water recharge generally occurs in spring. Recharge also occurs during late fall, between the first killing frost and the time when the ground freezes. Ground-water recharge is less during summer and early fall, when much precipitation is consumed through evapotranspiration.

Seasonal variation in precipitation is more critical to the maintenance of ground-water levels than the annual total. A dry spring or fall could have considerably more effect on ground-water levels than a dry summer.

4. Surface Water/Ground-Water Interaction

Ground water is in constant motion from points of recharge to points of discharge, which are springs and streams. Ground water makes up about 58 percent of stream flow in the Upper Susquehanna Subbasin during average conditions (Taylor, 1984) and provides nearly all stream flow during low flow conditions. Any withdrawal from ground water may alter stream flows at some later date.

If the water table in an aquifer is lowered to a level less than the water level in a stream crossing the aquifer, stream water may infiltrate into the aquifer. Recharge of the aquifer may be induced when the pumping of a well located near a stream

alters the natural water-table gradient so that water moves from the stream to the well.

If water withdrawn from a well is returned to a stream, the net effect is to provide a more direct route to the stream by way of the discharge pipeline. If pumping is continuous, the stream depletion rate approaches the pumping rate. The impact of the ground-water withdrawal on the stream will be determined by how and where the water is returned to the stream. If pumping is seasonal and occurs only during a dry period, it is possible that the major part of the stream depletion caused by pumping will come after the low flow period. However, if the well is located very close to the stream, the effect may be the same as a direct diversion.

5. Water Quality

The SRBC conducted a water quality and biological survey of the Upper Susquehanna Subbasin (Malione and others, 1984) and maintains a Stream Assessment Database for the Susquehanna River Basin. Of the 1,338 stream miles from the Upper Susquehanna Subbasin that were assessed and entered into the SRBC's Stream Assessment Database, the State's designated uses were met in 1,105.1 stream miles. The State's designated uses were not met in 153.5 stream miles and were partially met in 79.4 stream miles. Table 4 lists streams in the Upper Susquehanna Subbasin with impaired water quality.

Ground-water quality in the Upper Susquehanna Subbasin is generally adequate for most uses (Taylor, 1984). Iron and manganese are the natural constituents in ground water that are most troublesome. More than 36 percent of the well samples analyzed had concentrations of one or both of these elements that were greater than the recommended limits of the U.S. Environmental Protection Agency (Taylor, 1984). The most common ground-water contamination problems reported involved bacterial organisms from sewage, hydrocarbons from buried storage tanks and industrial processes, excessive nitrates, landfill leachate, and acid mine drainage. The majority of these problems are local in extent and are often confined to individual wells.

6. Recreation

The Upper Susquehanna Subbasin offers a wide variety of water-based recreational opportunities. The Pa. DER (1986b) has reported no deficiencies in water-based recreational facilities for the region. Demand for this type of recreation is expected to grow in the future.

Many stocked streams provide good trout fishing opportunities (Pennsylvania Fish Commission, undated). The Susquehanna River and a number of small lakes provide good fishing for warmwater fish species. The six state parks located in the subbasin provide additional swimming, fishing, and boating opportunities.

TABLE 4

STREAMS IN THE UPPER SUSQUEHANNA SUBBASIN HAVING IMPAIRED WATER QUALITY

Stream	Reach	Mi. Partially Mtg. State's Desig. Uses	Mi. Not Mtg. State's Desig. Uses	Tot. Mi. Assessed
Ackerly Creek	S. Br. to S. Br. Tunkhannock Crk.	4.7 (Municipal Wastes)		8.7
Black Creek	Source to Nescopeck Creek		23.5 (Acid Mine Drainage)	23.5
Catawissa Creek	Source to Susquehanna River		42.4 (Acid Mine Drainage)	42.4
Coal Brook	Source to Lackawanna River		1.9 (Acid Mine Drainage)	2.2
Eddy Creek	Unnamed Tributary to Lackawanna River		3.0 (Unknown Pollution Source)	7.0
Fall Brook	Unnamed Tributary to Lackawanna River		1.1 (Unknown Pollution Source)	7.1
Grassy Island Creek	Elevation 1100 to Lackawanna River		1.3 (Unknown Pollution Source)	1.3
Keyser Creek	Source to Lackawanna River		4.8 (Unknown Pollution Source)	6.3
Lackawanna River	Wayne County Line to Susquehanna River	22.6 (Acid Mine Drainage)	2.6	25.2
Little Nescopeck Creek	Source to Nescopeck Creek		9.1 (Acid Mine Drainage)	9.1

Stream	Reach	Mi. Partially Mtg. State's Desig. Uses	Mi. Not Mtg. State's Desig. Uses	Tot. Mi. Assessed
Lucky Run	Source to Keyser Creek		0.9 (Unknown Pollution Source)	2.8
Meadow Brook	Source to Lackawanna River		2.1 (Unknown Pollution Source)	2.1
Mill Creek	Source to Susquehanna River	0.5 (Urban Trash)		14.2
Mill Creek	Source to Lackawanna River		4.1 (Unknown Pollution Source)	6.8
Nanticoke Creek	Source to Susquehanna River		3.6 (Acid Mine Drainage)	5.0
Nescopeck Creek	Pa. 309 to Susquehanna River		13.5 (Acid Mine Drainage)	25.7
Newport Creek	Source to Susquehanna River		4.8 (Acid Mine Drainage)	4.8
Pettis Creek	Source to Wyalusing Creek	0.5 (Municipal Wastes)		3.6
Powderly Creek	Source to Lackawanna River		1.9 (Acid Mine Drainage)	1.9
Red Spring Run	Lackawanna County Line to Lackawanna River		0.6 (Unknown Pollution Source)	0.6
Schrader Creek	Sullivan County Line to Towanda Creek	4.0 (Acid Mine Drainage)	8.5	20.7

Stream	Reach	Mi. Partially Mtg. State's Desig. Uses	Mi. Not Mtg. State's Desig. Uses	Tot. Mi. Assessed
Solomon Creek	Source to Susquehanna River	3.3 (Acid Mine Drainage)	1.5	9.0
S. Br. Wyalusing Creek	Source to E. Br. Wyalusing Creek	9.0 (Agricultural Runoff)		9.0
St. Johns Creek	Unnamed Trib. to Lackawanna River		4.8 (Unknown Pollution Source)	6.0
Stafford Meadow Brook	Moosic/Scranton Line to Lackawanna River	2.4 (Urban Runoff)		2.4
Sterry Creek	Source to Lackawanna River		2.4 (Unknown Pollution Source)	3.8
Sugar Run Creek	Source to Sugar Run	0.5 (Industrial Wastes)		9.5
Susquehanna River	Chemung River to Wyoming County Line	0.5 (Industrial Wastes)		39.8
Susquehanna River	Lackawanna River to Columbia County Line	26.0 (Acid Mine Drainage)	2.0	36.5
Toby Creek	Source to Susquehanna River	1.4 (Unknown Pollution Source)	1.0	11.5
Tomhickon Creek	Source to Catawissa Creek		10.6 (Acid Mine Drainage)	10.6
Wildcat Creek	Source to Lackawanna River		0.9 (Unknown Pollution Source)	3.3

Stream	Reach	Mi. Partially Mtg. State's Desig. Uses	Mi. Not Mtg. State's Desig. Uses	Tot. Mi. Assessed
Wilson Creek	Source to Lackawanna River		0.6 (Acid Mine Drainage)	3.6
Wyalusing Creek	Susquehanna County Line to Susquehanna River	4.0 (Domestic Wastes)		14.7
TOTALS		79.4	153.5	380.7

Source: McMorran (1989) and SRBC Stream Assessment Database.

C. POPULATION

Population is concentrated in the area from Scranton to Wilkes-Barre, known locally as the Wyoming Valley. Comparison of census data indicates that the subbasin experienced a 3.24 percent increase in population between 1970 and 1980. However, the subbasin's population is projected to decrease through the year 2010. Population statistics are listed in Tables 5 and 6.

D. LAND USE

The Upper Susquehanna Subbasin has large areas of undeveloped land. More than half of the subbasin area is forest and about one third of the area is agricultural or open land (Pa. DER, 1978 and 1979). Only about 7 percent of the area is urban or built-up land, and about 7 percent falls into other land use categories. Much of the area's urban and industrial development is concentrated in the Wyoming Valley.

In the future, the amount of forested and urban or built-up land is expected to increase, while the amount of agricultural land is expected to decrease (Pa. DER, 1978 and 1979). The amount of land used for other purposes is expected to increase slightly by the year 2020.

E. BUSINESS AND INDUSTRY

Anthracite coal mining arose as an industry in the Wyoming Valley in the early 1800's. Anthracite coal became popular as a

TABLE 5

POPULATION STATISTICS

Area	1970 Population	1980 Population	Percent Change
Upper Susquehanna Subbasin	709,477	732,448	+3.24
Bradford Co., Pa.	57,962	62,919	+8.55
Columbia Co., Pa.	55,114	61,967	+12.43
Lackawanna Co., Pa.	243,107	227,908	-6.25
Luzerne Co., Pa.	342,301	343,079	+0.23
Wyoming Co., Pa.	19,082	26,433	+30.52
Scranton City	103,564	88,117	-14.92
Wilkes-Barre City	58,856	51,551	-12.41

Based on Pa. DER (1987).

TABLE 6

POPULATION PROJECTIONS

Area	1980	1990	2000	2010
Upper Susquehanna Subbasin	732,448	713,369	691,072	674,231
Bradford Co., Pa.	62,919	65,551	67,323	68,429
Columbia Co., Pa.	61,967	62,584	64,758	65,416
Lackawanna Co., Pa.	227,908	220,679	213,361	205,710
Luzerne Co., Pa.	343,079	325,954	305,954	294,289
Wyoming Co., Pa.	26,433	28,525	30,198	31,520
Scranton City	88,117	78,020	69,954	64,404
Wilkes-Barre City	51,551	44,229	38,468	35,843

Based on Pa. DER (1987).

fuel for household heating and, together with the area's iron ore, was used for the manufacture of iron by the middle of the nineteenth century. The City of Scranton had its origins as an iron-making community.

The Susquehanna River provided a means of transporting coal and iron from the area during the early 1800's. However, rafts and arks could only navigate the river during treacherous, high-water conditions. The development of canals and then railroads in the 1850's did much to open up distant markets to the Wyoming Valley's coal and iron products.

Manufacturing became important in the late nineteenth century, although the area was still dependent on coal for its primary source of income. The demand for coal dropped in the 1920's, resulting in economic hardship for the area.

Past mining practices have left many areas with scarred landscapes and huge piles of coal refuse. However, with the development of new technology, many of the piles of low-grade, "culm" coal are being used as a fuel source by small scale electric generating facilities. Local officials are hopeful that the development of these energy supplies will attract new industry and economic development to the region.

Some manufacturing occurs in smaller trading centers outside the Wyoming Valley. Dairy farming is the most important agricultural industry. Lumbering also provides some limited employment opportunities.

Employment statistics for the subbasin are contained in Table 7. In 1985, the average per capita income for the subbasin was $8,985, which was below the statewide average of $10,288 (Pennsylvania State Data Center, 1989).

F. SUBBASIN SECTIONS

The following sections of the Upper Susquehanna Subbasin are discussed separately in this framework plan with respect to water use and low flow events:

1. Susquehanna River from mouth of Chemung River to Meshoppen Creek
2. Meshoppen Creek and Susquehanna River from Meshoppen Creek to Lackawanna River
3. Lackawanna River
4. Susquehanna River from mouth of Lackawanna River to and including Wapwallopen Creek
5. Susquehanna River from mouth of Wapwallopen Creek to mouth of West Branch Susquehanna River

The approximate boundaries of the above sections are included in Figure 2 (page 7).

TABLE 7

UPPER SUSQUEHANNA SUBBASIN
1986 EMPLOYMENT BY MAJOR INDUSTRY GROUPS

Employment Category	Percent of Total Employment
Agricultural Services, Forestry, Fisheries	0.3
Mining	0.6
Construction	3.2
Manufacturing	31.9
Transportation & Public Utilities	5.2
Wholesale Trade	5.4
Retail Trade	20.1
Finance, Insurance & Real Estate	5.1
Services	27.2
Other	1.0

Based on U.S. Dept. of Commerce (1988).

III. METHODOLOGY FOR WATER USE AND STORAGE CALCULATIONS

A. GENERAL

Water use data for the Upper Susquehanna Subbasin were derived from existing inventories and surveys, which were also used to project future water use. Water use estimates contained in this report represent potential demands during low flow conditions.

This framework plan uses the Q7-10 value as a target for comparison of potential water deficits during a low flow event. The Q7-10 value is used for comparison purposes and is not considered to be a minimum flow that must be maintained.

Consumptive water uses are important because they remove water from the stream or aquifer and make it unavailable for immediate re-use in downstream areas. Steam electric generating facilities and other industries whose operations result in water losses are consumptive users. However, a portion of domestic water supply is also consumed (lost). Lawn and garden watering result in losses through evapotranspiration. Additional losses may occur due to car washing, clothes drying, and other domestic uses. During low flow periods, the cumulative effects of consumptive losses become more important.

B. MUNICIPAL WATER USE

Estimates of municipal water use in the Upper Susquehanna Subbasin were obtained from the State Water Use Data System maintained by the State Water Plan Division of the Pa. DER. Water use data for large, self-supplied institutions such as universities, correctional facilities, and state parks were also obtained and included with municipal water use estimates. Baseline water use data for each system are included in this framework plan. Water use projections for each subbasin section are presented for the years 1990, 2000, and 2010.

Estimating the quantity of water consumed from municipal systems is difficult. Consumptive use rates vary locally, and are dependent on the kinds of industrial uses, the condition of the water supply conveyance system, and the standards of living and habits of domestic water users.

One method of calculating consumptive use for a municipal system involves estimating the amount of water withdrawn by the water supply system and subtracting the amount discharged through the municipality's sewage treatment plant. However, the geographic areas served by water supply and sewer systems may not coincide. Also, some users may use only one system. For example, an industry may have its own water supply, yet be connected to the municipal sewer system. This method of calculating consumptive use is further complicated by the fact that most water systems experience some leakage. Also, most

sewer systems experience some infiltration from ground water during wet periods, and exfiltration during dry periods. Both of these processes vary from system to system and further complicate consumptive use calculations.

The Pa. DER State Water Plan Division uses 10 percent as an estimate of consumptive use by municipal systems. Preliminary studies of the Carlisle and Red Lion, Pa. water supply systems by SRBC staff indicate that consumptive use by these communities ranged up to 20 percent of their total withdrawals depending on time of year. A consumptive loss estimate of 20 percent was considered applicable during late summer low flow periods. This value agrees closely with the estimated value of 22 percent consumptive use cited by Dunne and Leopold (1978) as a national average for municipal systems in the United States. The U.S. Geological Survey (Solley and others, 1983) has estimated that this national average is about 21 percent. For the purpose of this low flow management framework plan, consumptive use for municipal systems was calculated by multiplying the average daily use value by 20 percent.

C. SELF-SUPPLIED INDUSTRIAL WATER USE

Water use data for self-supplied industries, including mining operations, were also obtained from the State Water Use Data System maintained by the State Water Plan Division of the Pa. DER. The general trends in economic activity in Pennsylvania were compared for twenty major two-digit Standard Industrial

Classification (SIC) code groups (Appendix A). Economic trends in coal production were also examined.

Water use was assumed to be proportional to the value added to the product by the manufacturer. The values added by the manufacturer were obtained from the Census of Manufacturers for the years 1958, 1963, 1967, 1972, 1977, and 1982. These values were adjusted to 1972 constant dollars using an implicit price deflator published in the 1984 Economic Report of the President. Figures for value added by manufacturer were not available for coal production. Therefore, water use was assumed proportional to tons of coal mined. Values for tons of coal produced were obtained from the Pa. DER's 1986 Annual Report on Mining Activities for the years 1951, 1956, 1961, 1966, 1971, 1976, 1981, and 1986 (Pa. DER, 1986a).

The above values were plotted against their corresponding years and the projected values for the years 1990, 2000, and 2010 were determined for each industry using least squares analysis. Ratios of the projected values to the base year 1980 for each industrial group were multiplied by the particular industry's 1980 water use to determine the projected water use for the corresponding year. Appendix A includes a table showing the ratio of the projected value added to the base year 1980 for each industrial group that showed increasing economic activity.

Consultation with Pa. DER Bureau of Mine Reclamation staff indicates that economic activity in non-coal mineral industries is being maintained at a relatively constant level. For the purposes of this framework plan, water use by non-coal mineral industries was assumed constant through the year 2010.

Any given industry may show economic activity that is different from the general trends for its related SIC group. Therefore, for the purpose of this framework plan, the 1980 water use for any industry showing a declining economic activity was assumed constant over the projected years of 1990, 2000, and 2010. Water use for the growth industries was estimated by using the water use increase ratio as previously described. The industrial projections cited in this report should be considered as worst case estimates of future water use.

Consumptive use data for self-supplied mineral and non-mineral industries were calculated using a consumptive water use index developed by the Pa. DER State Water Plan Division. This index lists industries by SIC code and gives estimated consumptive use as a percentage of each industry's total water use (Appendix A). Values for the index were obtained from the U.S. Department of Commerce's Census of Manufactures - Water Use in Manufacturing.

D. SELF-SUPPLIED DOMESTIC WATER USE

Because individual domestic wells generally provide only limited supplies, estimates of self-supplied domestic use were not calculated and were not considered essential for the development of this framework plan. Further, domestic wells often may be located where the potential for effects on stream flows is minimal.

E. AGRICULTURAL WATER USE

Irrigation and livestock data were used to estimate daily agricultural water demands. Although minor quantities of water are used for the application of herbicides, fungicides, insecticides, and fertilizers, these applications are generally performed early in the year, prior to the development of low flow conditions. Therefore, water uses relating to these applications were not considered essential to development of this framework plan.

Agricultural water use estimates in this report were derived from limited data using many assumptions. Additional difficulties arose in attempting to predict future agricultural water use. Changes in farming practices and market conditions are inevitable and could grossly affect both irrigation and livestock water use.

1. Livestock Water Use

Livestock data for Bradford, Columbia, Lackawanna, Luzerne, Montour, Susquehanna, and Wyoming Counties were obtained from the

U.S. Censuses of Agriculture for 1969, 1974, 1978, and 1982. Daily water use requirements per animal were obtained from a publication by the Midwest Plan Service (1979). These daily water use estimates agreed closely with similar estimates cited in the Pennsylvania State Water Plan (Pa. DER, 1975). Total water use by livestock was calculated by multiplying the daily water use per animal by the number of animals. Consumptive use of water by livestock was considered to average about 75 percent, as reported by Dunne and Leopold (1978) and the Pennsylvania State Water Plan. Livestock water use estimates for the counties referenced above are included in Appendix C.

The methodology for estimating potential livestock water use included the following steps:

a. Water use per unit area was calculated for each county;

b. The area of each county in each stream section was determined;

c. Appropriate values from Step a. were multiplied by values from Step b. to calculate the water use for the areas of each county in each stream section; and

d. Appropriate values from Step c. were summed to determine water use for each stream section.

Due to a lack of data and the uncertainties of projecting future use, livestock data for the year showing the greatest number of animals were considered to be representative of potential livestock demands during low stream flow conditions through the year 2010.

2. Irrigation

Farm irrigation water use was estimated using a methodology similar to that described in the Pennsylvania State Water Plan (Pa. DER, 1975). Farmland acreages and irrigation data were obtained from the U.S. Censuses of Agriculture for each county referenced above. Average daily water use for irrigation during each census year was estimated by first multiplying the number of acres irrigated by 1/2 inch of water applied per week during the irrigation season and then converting the units to gallons per day.

Much of the water used for irrigation is lost due to evaporation and transpiration by plants. The Pennsylvania State Water Plan (Pa. DER, 1975) estimated that about 100 percent of the water used for irrigation is consumed. On the basis of computer model simulations for two crops (potatoes and small vegetables), Kibler and others (1977) calculated a seasonal, crop-weighted average consumptive use value of about 82.5 percent. Data from Dunne and Leopold (1978) for the entire United States suggest that consumptive losses associated with irrigation average about 81 percent. A consumptive use coefficient of about 85 percent was cited by Steenhuis and others (1986) for the Susquehanna River Basin in New York State. For the purpose of this framework plan, consumptive use of irrigation water was considered to average about 85 percent of the total irrigation water used.

County irrigation data for farmland are included in Appendix C. These data were used to calculate farm irrigation in each stream section using the same methodology described previously in the Livestock Water Use section.

There are many golf courses in the Upper Susquehanna Subbasin. Estimates of existing water use for golf course irrigation were taken from the Pa. DER's State Water Use Data System. Golf course irrigation estimates were added to the farmland irrigation estimates for each stream section for the year showing the greatest water use. The results were considered representative of irrigation demands in each section through the year 2010.

F. COMPUTATION OF STORAGE REQUIRED TO MAINTAIN THE Q7-10 VALUE

The amount of reservoir storage that would be required to maintain the Q7-10 flow considering future consumptive losses was computed as follows (Section IX.B.):

a. Historical data for the following stream gages were used to calculate flows at the outlets of the subbasin sections:

- No. 01531500, Susquehanna River at Towanda, Pa.
- No. 01532000, Towanda Creek near Monroeton, Pa.
- No. 01534000, Tunkhannock Creek near Tunkhannock, Pa.
- No. 01536000, Lackawanna River at Old Forge, Pa.
- No. 01536500, Susquehanna River at Wilkes-Barre, Pa.
- No. 01540500, Susquehanna River at Danville, Pa.

b. Q7-10 values were determined for each of these gages using standard USGS procedures;

c. Critical low flow periods were determined from the records for each gage;

d. Daily streamflows for the critical periods were extracted from the USGS WATSTORE computer files, and adjusted for effects of increased or decreased drainage area either downstream or upstream from the gage by using drainage area ratios; the Q7-10 values were similarly adjusted;

e. The total upstream consumptive use (C) was added to the adjusted Q7-10 value to obtain the subarea value of Q7-10+C;

f. If the natural flow on any day was less than the daily value of Q7-10+C, the difference was computed and accumulated for the most critical climatic year (ending March 30) in order to determine storage.

Note that due to different periods of record for different gaging stations, as well as differing geologic, climatic, and hydrologic conditions from site to site, calculated Q7-10 values based on historic records cannot simply be added along the length of the subbasin. The calculated Q7-10 value for the mouth of the subbasin is not necessarily equal to the sum of the calculated Q7-10 values for all tributaries upstream of that point.

IV. SUBBASIN SECTION 1

SUSQUEHANNA RIVER FROM MOUTH OF CHEMUNG RIVER TO MESHOPPEN CREEK

A. WATER USE

1. Municipal Water Use

Table 8 summarizes baseline water use data for the 10 public suppliers withdrawing water from Section 1. Total and consumptive use estimates through the year 2010 are shown in Table 9. Public water supply data obtained from the Pa. DER indicate that total average daily water use under baseline conditions is about 1.67 million gallons per day (MGD). Total projected demand on public systems is expected to decline and then increase slightly to about 1.60 MGD by the year 2010. The calculated total consumptive use for public systems under baseline conditions is 0.33 MGD, while projected consumptive use by the year 2010 is 0.32 MGD.

2. Self-Supplied Non-Mineral Industrial Water Use

Total water demand and consumptive use estimates for self-supplied industries other than mining are summarized in Tables 10 and 11. Total water use during potential low flow conditions is expected to increase from about 5.08 MGD under baseline conditions to about 5.17 MGD by the year 2010. Consumptive use is estimated to be about 0.40 MGD through the year 2010.

During normal conditions, the Masonite Corporation consumes all of its total ground-water withdrawal of 0.753 MGD. The

TABLE 8

BASELINE MUNICIPAL WATER USE DATA FOR SECTION 1
OF THE UPPER SUSQUEHANNA SUBBASIN

Municipal System Name	Source	County	Pop. on System	Avg. Water Use (gpd)	GPCD	Peak Water Use (gpd)	Peak/Avg. Ratio
Bradford County Manor	GW	Bradford	210	21,000	100.0	31,500	1.50
Canton Boro Authority	SW,GW	Bradford	2,053	273,700	133.5	410,550	1.50
Laceyville Boro Water Co.	GW	Wyoming	525	36,910	70.3	42,077	1.14
LeRaysville Water Co.	GW	Bradford	352	28,800	81.7	43,200	1.50
New Albany Mun. Water Co.	SW,GW	Bradford	356	27,970	78.7	71,955	1.50
Towanda Mun. Water Authority	SW,GW	Bradford	5,134	1,070,300	208.4	1,605,450	1.50
Troy Boro Water Dept.	SW,GW	Bradford	1,448	116,510	80.1	174,765	1.50
Ulster Mun. Authority	GW	Bradford	370	41,400	111.9	62,100	1.50
Wells Mill Co.	GW	Bradford	37	10,900	291.2	16,350	1.50
Wyalusing Mun. Water Works	SW,GW	Bradford	716	43,000	60.1	64,500	1.50
TOTALS			11,201	1,670,490		2,492,447	

Key to Abbreviations:

SW-Surface Water
GW-Ground Water

gpd-gallons per day
GPCD-gallons per capita per day

TABLE 9

MUNICIPAL WATER USE PROJECTIONS FOR SECTION 1
OF THE UPPER SUSQUEHANNA SUBBASIN

Parameter	Base	1990	2000	2010
Population Served	11,201	10,758	10,562	10,670
Avg. Daily Water Use (gpd)	1,670,490	1,602,210	1,581,830	1,600,330
Consumptive Use (gpd)	334,098	320,442	316,366	320,066
Peak Water Use (gpd)	2,492,447	2,391,291	2,360,293	2,387,096

TABLE 10

NON-MINERAL INDUSTRIAL WITHDRAWALS IN SECTION 1
TOTAL USE

Withdrawal	Source	Base (gpd)	1990 (gpd)	2000 (gpd)	2010 (gpd)
A.J. Dress Co.	GW	1,200	1,200	1,200	1,200
Ames Co.	GW	39	39	39	39
ASL Industrial Inc.	GW	2,670	2,670	2,670	2,670
Belmar Mfg. Co.	GW	316	316	316	316
Bendix Corp.(1)	GW	69,200	69,200	69,200	69,200
Bendix Corp.(2)	SW	100,000	100,000	100,000	100,000
Brunges Pallet Mfg.	GW	320	320	320	320
Cornell Mfg. Inc.	GW	904	904	904	904
Cummings Lumber Co.(1)	SW	200	200	200	200
Cummings Lumber Co.(2)	GW	40	40	40	40
Dibble Lumber	GW	60	60	60	60
DuPont de Nemours	GW	49,200	61,500	75,276	89,052
Edgewood Farms	GW	1,380	1,573	1,739	1,904
GTE Products Corp.	GW	3,670,000	3,670,000	3,670,000	3,670,000
H. Rockwell & Son	SW	77	88	97	106
Hoovers Sawmill	GW	150	150	150	150
James A. Gustin	GW	1,000	1,140	1,260	1,380
Janner Inc.	GW	1,900	1,900	1,900	1,900
Leona Meat Plant	GW	1,170	1,334	1,474	1,615
Masonite Corp.*	GW	0	0	0	0
Ribstone Silos of Pa.	GW	1,000	1,000	1,000	1,000
Serve Inc.	GW	400	476	548	620
State Aggregates Inc.	SW	1,050,000	1,050,000	1,050,000	1,050,000
Taylor Meat Packing	GW	127,000	144,780	160,020	175,260
Troy Meat Packing Inc.	GW	1,300	1,482	1,638	1,794
Welles Mill Co.	GW	330	376	416	455
Willard Bates & Son	GW	50	66	71	76
Total		5,079,906	5,110,814	5,140,538	5,170,261

* Project is subject to the SRBC consumptive use make-up regulation (SRBC Project Review files, Sept. 1989). During normal conditions (base year through 2010), total use is expected to be 753,000 gpd. The total withdrawal is consumed. Pumping will cease when the flow of the Susquehanna River at Towanda equals or is expected to equal the Q7-10 value plus the project's consumptive use.

TABLE 11

NON-MINERAL INDUSTRIAL WITHDRAWALS IN SECTION 1
CONSUMPTIVE USE

Withdrawal	SIC	Base (gpd)	1990 (gpd)	2000 (gpd)	2010 (gpd)
A.J. Dress Co.	23	92	92	92	92
Ames Co.	24	3	3	3	3
ASL Industrial Inc.	22	312	312	312	312
Belmar Mfg. Co.	24	24	24	24	24
Bendix Corp.(1)	37	4,422	4,422	4,422	4,422
Bendix Corp.(2)	37	6,390	6,390	6,390	6,390
Brunges Pallet Mfg.	24	25	25	25	25
Cornell Mfg. Inc.	35	38	38	38	38
Cummings Lumber Co.(1)	24	15	15	15	15
Cummings Lumber Co.(2)	24	3	3	3	3
Dibble Lumber	24	5	5	5	5
DuPont de Nemours	38	2,588	3,235	3,960	4,684
Edgewood Farms	20	99	112	124	136
GTE Products Corp.	28	246,624	246,624	246,624	246,624
H. Rockwell & Son	20	6	6	7	8
Hoovers Sawmill	24	12	12	12	12
James A. Gustin	20	72	82	90	99
Janner Inc.	23	146	146	146	146
Leona Meat Plant	20	84	95	105	115
Masonite Corp.*	24	0	0	0	0
Ribstone Silos of Pa.	32	131	131	131	131
Serve Inc.	27	31	37	42	48
State Aggregates Inc.	32	137,550	137,550	137,550	137,550
Taylor Meat Packing**	20	0	0	0	0
Troy Meat Packing Inc.	20	93	106	117	128
Welles Mill Co.	20	24	27	30	33
Willard Bates & Son	25	0	0	0	0
Totals		398,789	399,492	400,267	401,043

* Project is subject to the SRBC consumptive use make-up regulation (SRBC Project Review files, Sept. 1989). During normal conditions (base year through 2010), total use is expected to be 753,000 gpd. The total withdrawal is consumed. Pumping will cease when the flow of the Susquehanna River at Towanda equals or is expected to equal the Q7-10 value plus the project's consumptive use.

** Based on SRBC Project Review files (Sept. 1989).

project is subject to the requirements of the SRBC consumptive use make-up regulation (18 CFR Section 803.61) and was approved by the SRBC at its November 13, 1980 meeting. In order to comply with the requirements of the SRBC consumptive use make-up regulation, the project sponsor agreed to cease its ground-water withdrawal when the flow of the Susquehanna River at Towanda equals or is expected to equal the Q7-10 value plus the project's consumptive use.

3. Self-Supplied Mineral Industrial Water Use

Total water demand and consumptive use estimates for the two self-supplied mineral industries in the section are summarized in Tables 12 and 13. Total water use during potential low flow conditions is expected to increase from about 0.60 MGD under baseline conditions to about 0.62 MGD by the year 2010. Consumptive use is expected to increase from the baseline estimate of 0.03 MGD to 0.05 MGD in 1990, and to continue at that level through 2010.

The above increase is due to the Wyoming Sand and Stone Company's sand and gravel processing project that began 1989. The project is subject to the requirements of the SRBC consumptive use make-up regulation and was approved by the SRBC at its March 9, 1989 and July 13, 1989 meetings. During normal conditions, all of the project's total withdrawal of 55,400 gpd from the Susquehanna River is consumed. In order to meet the requirements of the SRBC consumptive use make-up regulation,

TABLE 12

MINERAL INDUSTRIAL WITHDRAWALS IN SECTION 1
TOTAL USE

Withdrawal	Source	Base (gpd)	1990 (gpd)	2000 (gpd)	2010 (gpd)
Towanda P.S. Aggregates	SW	600,000	600,000	600,000	600,000
Wyoming Sand & Stone*	SW	0	20,000	20,000	20,000
TOTALS		600,000	620,000	620,000	620,000

* Based on SRBC Project Review files (Sept. 1989). Project began in 1989 and is subject to the SRBC consumptive use make-up regulation. During normal conditions (1989 through 2010), total use is expected to be 55,400 gpd. The total withdrawal is consumed. Consumptive use will not exceed 20,000 gpd when stream flow at the point of taking equals or is expected to equal the Q7-10 value plus the project's consumptive use.

TABLE 13

MINERAL INDUSTRIAL WITHDRAWALS IN SECTION 1
CONSUMPTIVE USE

Withdrawal	SIC	Base (gpd)	1990 (gpd)	2000 (gpd)	2010 (gpd)
Towanda P.S. Aggregates	1,442	31,320	31,320	31,320	31,320
Wyoming Sand & Stone*	1,442	0	20,000	20,000	20,000
TOTAL		31,320	51,320	51,320	51,320

* Based on SRBC Project Review files (Sept. 1989). Project began in 1989 and is subject to the SRBC consumptive use make-up regulation. During normal conditions (1989 through 2010), total use is expected to be 55,400 gpd. The total withdrawal is consumed. Consumptive use will not exceed 20,000 gpd when stream flow at the point of taking equals or is expected to equal the Q7-10 value plus the project's consumptive use.

the project will reduce its consumptive use so it will not exceed 20,000 gpd when stream flow at the point of taking equals or is expected to equal the Q7-10 value plus the project's consumptive use.

4. Agricultural Water Use

Total livestock and irrigation water use are estimated to be 1.41 MGD and 0.51 MGD, respectively. Livestock and irrigation consumptive uses are estimated to be 1.06 MGD and 0.43 MGD. The Pa. DER reported no golf courses withdrawing water for irrigation purposes in Section 1. Livestock water use is greater in Section 1 than in any other section of the subbasin.

5. Summary of Water Use in Subbasin Section 1

Estimates of water use for Section 1 are listed in Tables 14 and 15. Water use values are given in both MGD and cfs to facilitate comparison with stream flows discussed in subsequent chapters.

B. OCCURRENCE OF Q7-10 VALUE

Table 16 and Figures 3 and 4 summarize the occurrence of flows at or below the Q7-10 value for the Susquehanna River at Towanda, Pa. Table 17 and Figures 5 and 6 summarize the occurrence of flows at or below the Q7-10 value for Towanda Creek near Monroeton, Pa. Flows at or below the Q7-10 value were recorded at the former site in July, August, September, October, and November, and at the latter site in July, August, and

TABLE 14

TOTAL WATER USE SUMMARY FOR SECTION 1*

User	Total Use (MGD)			
	Base	1990	2000	2010
Municipal				
Domestic & Industry	1.67	1.60	1.58	1.60
Industrial				
Non-Mineral Self-Supplied	5.08	5.11	5.14	5.17
Mineral Self-Supplied	0.60	0.62	0.62	0.62
Agriculture				
Livestock	1.41	1.41	1.41	1.41
Irrigation	0.51	0.51	0.51	0.51
TOTAL	9.27	9.25	9.26	9.31
	(14.34 cfs)	(14.31 cfs)	(14.33 cfs)	(14.41 cfs)

* Assuming potential low flow conditions.

TABLE 15

CONSUMPTIVE WATER USE SUMMARY FOR SECTION 1*

User	Consumptive Use (MGD)			
	Base	1990	2000	2010
Municipal				
Domestic & Industry	0.33	0.32	0.32	0.32
Industrial				
Non-Mineral Self-Supplied	0.40	0.40	0.40	0.40
Mineral Self-Supplied	0.03	0.05	0.05	0.05
Agriculture				
Livestock	1.06	1.06	1.06	1.06
Irrigation	0.43	0.43	0.43	0.43
TOTAL	2.25	2.26	2.26	2.26
	(3.48 cfs)	(3.50 cfs)	(3.50 cfs)	(3.50 cfs)

* Assuming potential low flow conditions.

TABLE 16

FLOWS AT OR BELOW THE 7-DAY 10-YEAR LOW FLOW VALUE
FOR SUSQUEHANNA RIVER AT TOWANDA, PA. DURING PERIOD 1913-1987
(USGS SITE NO. 01531500)

Calendar Year	No. of Days Occurred	Months Occurred/ No. Days Per Month
1936	1	Aug./1
1939	43	Jul./3, Aug./13, Sept./27
1941	15	Sep./9, Oct./6
1953	13	Aug./2, Sept./6, Oct./5
1955	1	Aug./1
1959	12	Sep./11, Oct./1
1962	20	Aug./6, Sep./14
1963	21	Oct./17, Nov./4
1964	104	Aug./20, Sep./30, Oct./30, Nov./24
1965	20	Jul./2, Aug./15, Sep./3
TOTAL	250	Jul./5, Aug./58, Sep./100, Oct./59 Nov./28

FIGURE 3

NUMBER OF DAYS 7-DAY 10-YEAR LOW FLOW OCCURRED DURING PERIOD 1913 – 1987 SUSQUEHANNA RIVER AT TOWANDA, PA.

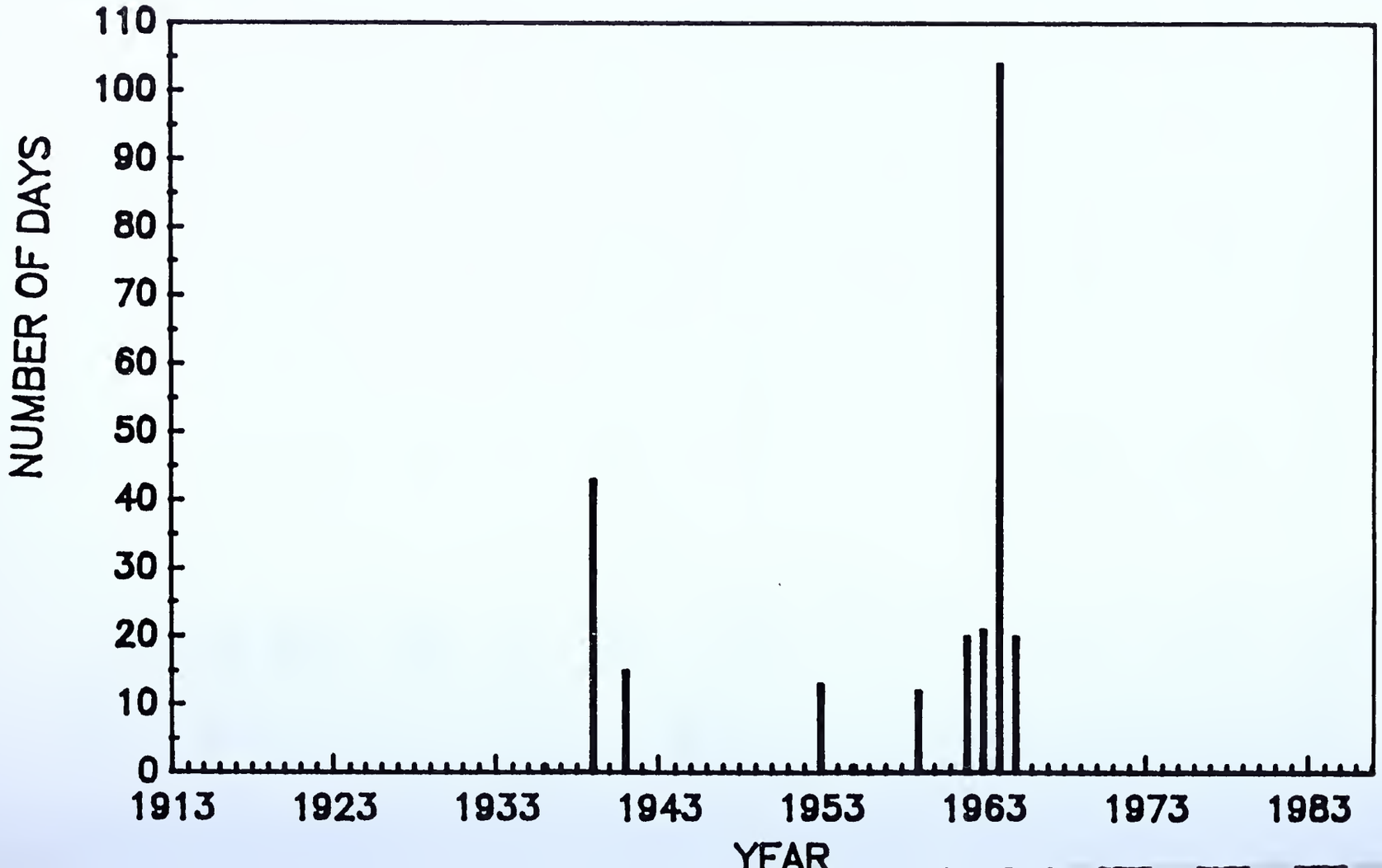


FIGURE 4

NUMBER OF DAYS 7-DAY 10-YEAR LOW FLOW OCCURRED IN EACH MONTH SUSQUEHANNA RIVER AT TOWANDA, PA. (FOR PERIOD 1913 – 1987)

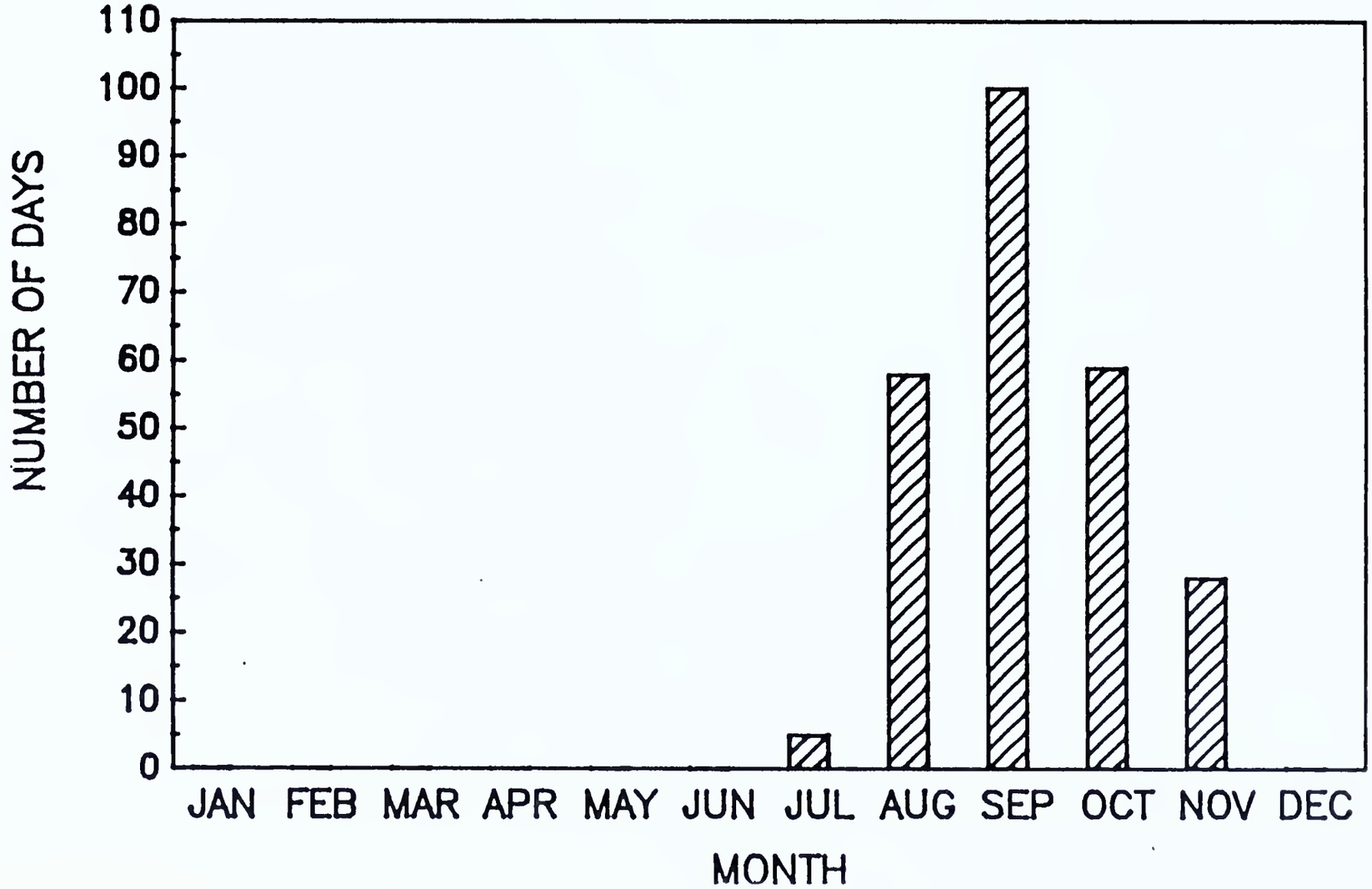


TABLE 17

FLOWS AT OR BELOW THE 7-DAY 10-YEAR LOW FLOW VALUE
FOR SUSQUEHANNA RIVER AT MONROETON, PA. DURING PERIOD 1914-1987
(USGS SITE NO. 01532000)

Calendar Year	No. of Days Occurred	Months Occurred/ No. Days Per Month
1932	24	Aug./2, Sep./22
1934	10	Jul./5, Aug./5
1936	22	Jul./4, Aug./5, Sep./13
1939	23	Jul./1, Aug./8, Sep./14
1955	11	Aug./11
1962	34	Aug./13, Sep./21
1964	35	Aug./7, Sep./28
1966	17	Aug./14, Sep./3
TOTAL	176	Jul./10, Aug./65, Sep./101

FIGURE 5

NUMBER OF DAYS 7–DAY 10–YEAR LOW FLOW OCCURRED DURING PERIOD 1914 – 1987 TOWANDA CREEK NEAR MONROETON, PA.

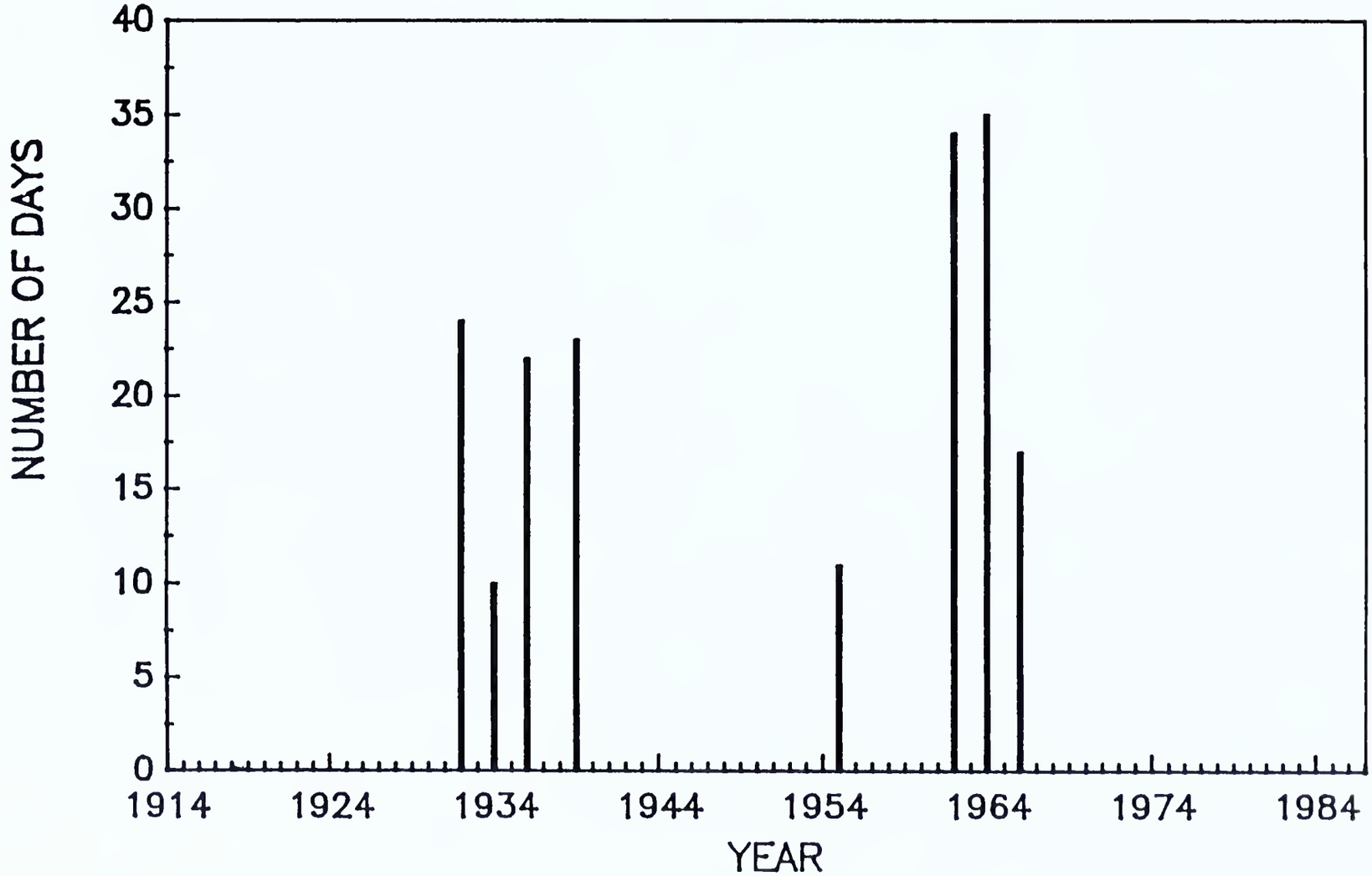
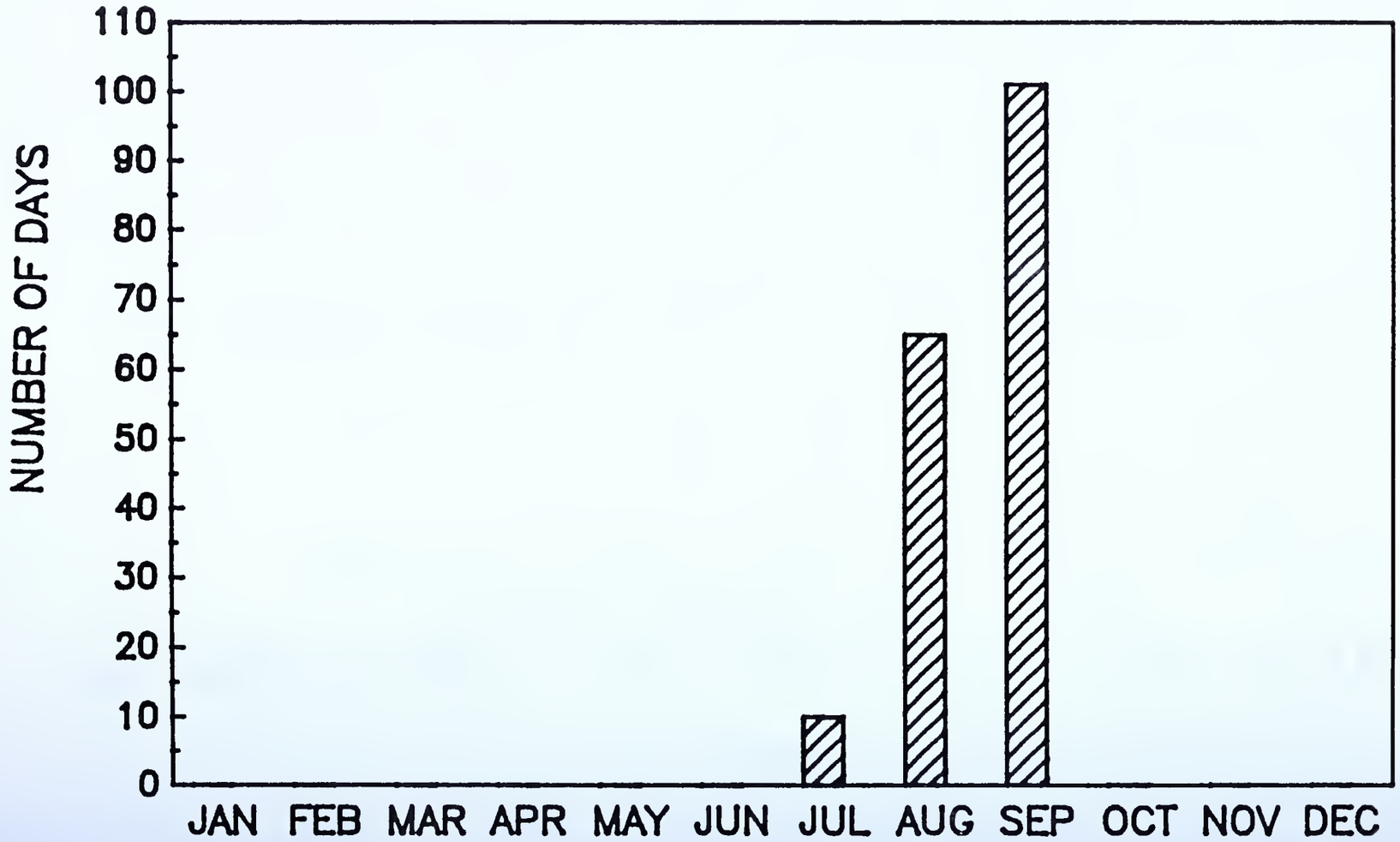


FIGURE 6

NUMBER OF DAYS 7–DAY 10–YEAR LOW FLOW OCCURRED
IN EACH MONTH
TOWANDA CREEK NEAR MONROETON, PA.
(FOR PERIOD 1914 – 1987)



September of various years. For both sites, flows of this magnitude occurred during more days in 1964 than in any other year of record.

V. SUBBASIN SECTION 2

MESHOPPEN CREEK AND SUSQUEHANNA RIVER FROM MESHOPPEN CREEK TO LACKAWANA RIVER

A. WATER USE

1. Municipal Water Use

Baseline water use data for the 19 public water suppliers withdrawing water from Section 2 are summarized in Table 18. Water use projections for the section are shown in Table 19. Total water use is expected to decrease slightly from the baseline estimate of 0.97 MGD and then increase to 1.06 MGD by 2010. Consumptive use is estimated to be 0.19 MGD under baseline conditions and 0.21 MGD in 2010.

2. Self-Supplied Non-Mineral Industrial Water Use

Total water demand and consumptive use data for self-supplied non-mineral industries in Section 2 are summarized in Tables 20 and 21. Total use is projected to increase from the baseline estimate of 12.87 MGD to 19.51 MGD in 2010. Consumptive use is projected to increase from the baseline estimate of 1.00 MGD to 1.51 MGD in 2010.

3. Self-Supplied Mineral Industrial Water Use

Water use estimates for self-supplied mineral industries in Section 2 are summarized in Tables 22 and 23. Currently, total and consumptive uses are estimated to be 4.27 MGD and 0.24 MGD, respectively, and are projected to remain at these levels through 2010. Total water use by mineral industries is greater in Section 2 than in any other section of the subbasin.

TABLE 18

BASELINE MUNICIPAL WATER USE DATA FOR SECTION 2
OF THE UPPER SUSQUEHANNA SUBBASIN

Municipal System Name	Source	County	Pop. on System	Avg. Water Use (gpd)	GPCD	Peak Water Use (gpd)	Peak/Avg. Ratio
Aaronrod Co., Inc.	GW	Wyoming	236	7,510	31.8	8,036	1.07
Abington Twp. Water Dept.	GW	Lackawanna	467	30,000	64.2	36,900	1.23
Barrett Water Co.	GW	Luzerne	118	12,000	101.9	18,000	1.50
Brooklyn Water Co.	SW,GW	Susquehanna	82	6,200	75.8	7,998	1.29
Clarks Summit State Hospital	GW	Lackawanna	524	125,000	238.5	187,500	1.50
Hex Acres Water Co.	GW	Luzerne	267	32,000	119.8	48,000	1.50
Hop Bottom Water Co.	SW,GW	Susquehanna	385	66,600	50.7	85,248	1.28
Loren Dixon Water Co.	GW	Wyoming	99	7,900	79.9	15,010	1.90
Mehoopany Water Co.	SW,GW	Wyoming	124	8,100	65.3	8,829	1.09
Meshoppen Water Co.	GW	Wyoming	571	72,000	126.1	79,920	1.11
Nicholson Boro Authority	SW	Wyoming	945	120,000	127.0	120,000	1.00
North Penn Utilities Inc.	GW	Wyoming	603	78,400	130.0	84,672	1.08
Noxen Water Co.	GW	Wyoming	271	30,300	111.8	42,117	1.39
Rivercrest Public Service	GW	Wyoming	248	14,700	59.2	16,023	1.09
Rivercrest Public Water Corp.	GW	Wyoming	509	27,000	53.0	29,970	1.11

TABLE 18
(Cont'd)

BASELINE MUNICIPAL WATER USE DATA FOR SECTION 2
OF THE UPPER SUSQUEHANNA SUBBASIN

Municipal System Name	Source	County	Pop. on System	Avg. Water Use (gpd)	GPCD	Peak Water Use (gpd)	Peak/Avg. Ratio
Sunset Hills Water Co.	GW	Lackwanna	132	10,300	78.0	12,051	1.17
Tambur Water-works	GW	Luzerne	86	9,000	104.7	13,500	1.50
Tunkhannock Boro Mun. Auth.	SW,GW	Wyoming	2,356	304,400	129.0	353,104	1.16
W-P Water Co., Inc.	GW	Wyoming	130	5,600	43.2	5,600	1.00
TOTALS			8,153	967,010		1,172,478	

TABLE 19

MUNICIPAL WATER USE PROJECTIONS FOR SECTION 2
OF THE UPPER SUSQUEHANNA SUBBASIN

Parameter	Base	1990	2000	2010
Population Served	8,153	8,110	8,632	9,135
Avg. Daily Water Use (gpd)	967,010	942,310	1,002,680	1,060,300
Consumptive Use (gpd)	193,402	188,462	200,536	212,060
Peak Water Use (gpd)	1,172,478	1,150,316	1,221,071	1,287,174

TABLE 20

NON-MINERAL INDUSTRIAL WITHDRAWALS IN SECTION 2
TOTAL USE

Withdrawal	Source	Base (gpd)	1990 (gpd)	2000 (gpd)	2010 (gpd)
Agway Inc.	GW	400	400	400	400
Aiken Associates	GW	1,420	1,420	1,420	1,420
Bocar Apparel Co.	GW	816	816	816	816
Celotex Corp.	GW	96,200	96,200	96,200	96,200
Clifford Mfg. Co.	GW	352	352	352	352
Creavey Seal Co.	GW	46	46	46	46
Darling Locker Plant	GW	6,100	6,954	7,686	8,418
Deer Park Lumber	GW	300	300	300	300
East Benton Packing Co.(1)	GW	1,000	1,140	1,260	1,380
East Benton Packing Co.(2)	GW	1,720	1,961	2,167	2,374
Falls Dress Co.	GW	667	667	667	667
Fisher Stoves of Pa.	GW	1,470	1,470	1,470	1,470
Masters Ready-Mix	GW	2,930	2,930	2,930	2,930
Mountdale Farm Dairy	GW	3,460	3,944	4,360	4,775
N.C. Stauffer & Sons	GW	275	344	421	498
Nicholson Rug	GW	108	108	108	108
Nu Feeds Inc.	GW	800	912	1,008	1,104
Pemco Specialty	GW	60	60	60	60
Precision National	GW	1,740	1,740	1,740	1,740
Pope & Talbot(1)	GW	8,900	9,968	11,748	13,528
Pope & Talbot(2)	SW	1,340,000	1,500,800	1,768,800	2,036,800
Procter & Gamble(1)	GW	200,000	224,000	264,000	304,000
Procter & Gamble(2)	SW	11,200,000	12,544,000	14,784,000	17,024,000
Quality Products	GW	570	570	570	570
Ross Feeds Inc.	GW	40	46	50	55
Tempifier Co.	GW	2	2	2	2
Tri-Our Minute Steaks	GW	98	112	123	135
Tunnel Hill Dairy	GW	1,040	1,186	1,310	1,435
Tuscarora Electric	GW	158	158	158	158
William Wentz Inc.	GW	27	30	36	41
Total		12,870,699	14,402,636	16,954,208	19,505,782

TABLE 21

NON-MINERAL INDUSTRIAL WITHDRAWALS IN SECTION 2
CONSUMPTIVE USE

Withdrawal	SIC	Base (gpd)	1990 (gpd)	2000 (gpd)	2010 (gpd)
Agway Inc.	28	27	27	27	27
Aiken Associates	39	101	101	101	101
Bocar Apparel Co.	23	63	63	63	63
Celotex Corp.	32	12,602	12,602	12,602	12,602
Clifford Mfg. Co.	23	27	27	27	27
Creavey Seal Co.	32	6	6	6	6
Darling Locker Plant	20	436	497	550	602
Deer Park Lumber	24	23	23	23	23
East Benton Packing Co.(1)	20	72	82	90	99
East Benton Packing Co.(2)	20	123	140	155	170
Falls Dress Co.	23	51	51	51	51
Fisher Stoves of Pa.	34	65	65	65	65
Masters Ready-Mix	32	384	384	384	384
Mountdale Farm Dairy	20	247	282	312	341
N.C. Stauffer & Sons	38	14	18	22	26
Nicholson Rug	22	13	13	13	13
Nu Feeds Inc.	20	57	65	72	79
Pemco Specialty	29	9	9	9	9
Precision National	34	77	77	77	77
Pope & Talbot(1)	26	688	771	908	1,046
Pope & Talbot(2)	26	103,582	116,012	136,728	157,445
Procter & Gamble(1)	26	15,460	17,315	20,407	23,499
Procter & Gamble(2)	26	865,760	969,651	1,142,803	1,315,955
Quality Products	35	24	24	24	24
Ross Feeds Inc.	20	3	3	4	4
Tempifier Co.	35	0	0	0	0
Tri-Our Minute Steaks	20	7	8	9	10
Tunnel Hill Dairy	20	74	85	94	103
Tuscarora Electric	35	7	7	7	7
William Wentz Inc.	26	2	2	3	3
Totals		1,000,004	1,118,410	1,315,636	1,512,861

TABLE 22
MINERAL INDUSTRIAL WITHDRAWALS IN SECTION 2
TOTAL USE

Withdrawal	Source	Base (gpd)	1990 (gpd)	2000 (gpd)	2010 (gpd)
American Asphalt Paving	SW	16,000	16,000	16,000	16,000
Clifford Quarry	SW	500,000	500,000	500,000	500,000
D.L. Antoine Quarry	SW	160	160	160	160
Edmund Wikoski	SW	438	438	438	438
Lake Benton Peat Moss	GW	1,350	1,350	1,350	1,350
Mitchell Quarry	GW	160	160	160	160
Montrose Quarry(1)	GW	500,000	500,000	500,000	500,000
Montrose Quarry(2)	SW	50,000	50,000	50,000	50,000
Paul R. Custer	GW	232	232	232	232
Wyoming Sand & Stone(1)	SW	900,000	900,000	900,000	900,000
Wyoming Sand & Stone(2)	SW	2,300,000	2,300,000	2,300,000	2,300,000
TOTALS		4,268,340	4,268,340	4,268,340	4,268,340

TABLE 23

MINERAL INDUSTRIAL WITHDRAWALS IN SECTION 2
CONSUMPTIVE USE

Withdrawal	SIC	Base (gpd)	1990 (gpd)	2000 (gpd)	2010 (gpd)
American Asphalt Paving	1,442	835	835	835	835
Clifford Quarry	1,429	33,500	33,500	33,500	33,500
D.L. Antoine Quarry	1,429	11	11	11	11
Edmund Wikoski	1,429	29	29	29	29
Lake Benton Peat Moss	1,499	119	119	119	119
Mitchell Quarry	1,429	11	11	11	11
Montrose Quarry(1)	1,429	33,500	33,500	33,500	33,500
Montrose Quarry(2)	1,429	3,350	3,350	3,350	3,350
Paul R. Custer	1,429	16	16	16	16
Wyoming Sand & Stone(1)	1,442	46,980	46,980	46,980	46,980
Wyoming Sand & Stone(2)	1,442	120,060	120,060	120,060	120,060
TOTALS		238,411	238,411	238,411	238,411

4. Agricultural Water Use

Total livestock and irrigation water use are estimated to be 0.87 MGD and 2.17 MGD, respectively. Livestock and irrigation consumptive use are estimated to be 0.65 MGD and 1.84 MGD. About 34 percent of the water used for irrigation is used by golf courses. Golf course irrigation estimates are summarized in Table 24.

5. Summary of Water Use in Subbasin Section 2

Tables 25 and 26 summarize estimates of water use in Section 2 through the year 2010.

B. OCCURRENCE OF Q7-10 VALUE

Table 27 and Figures 7 and 8 summarize the occurrence of flows at or below the Q7-10 value for Tunkhannock Creek near Tunkhannock, Pa.

TABLE 24

GOLF COURSE WATER USE IN SECTION 2

Withdrawal	Source	Total Use (gpd)	Consumptive Use (gpd)
Lakeland Golf Course	GW	40,800	34,680
Shadowbrook Golf Course	GW	77,200	65,620
Glen Oak Golf Course(1)	GW	137,000	116,450
Glen Oak Golf Course(2)	GW	278,000	236,300
Twin Oaks Golf Course(1)	SW	20,500	17,425
Twin Oaks Golf Course(2)	SW	10,100	8,585
Fox Hill Country Club	GW	179,000	152,150
TOTALS		742,600	631,210

TABLE 25

TOTAL WATER USE SUMMARY FOR SECTION 2*

User	Total Use (MGD)			
	Base	1990	2000	2010
Municipal				
Domestic & Industry	0.97	0.94	1.00	1.06
Industrial				
Non-Mineral Self-Supplied	12.87	14.40	16.95	19.51
Mineral Self-Supplied	4.27	4.27	4.27	4.27
Agriculture				
Livestock	0.87	0.87	0.87	0.87
Irrigation	2.17	2.17	2.17	2.17
TOTAL	21.15	22.65	25.26	27.88
	(32.73 cfs)	(35.05 cfs)	(39.09 cfs)	(43.14 cfs)

* Assuming potential low flow conditions.

TABLE 26

CONSUMPTIVE WATER USE SUMMARY FOR SECTION 2*

User	Consumptive Use (MGD)			
	Base	1990	2000	2010
Municipal				
Domestic & Industry	0.19	0.19	0.20	0.21
Industrial				
Non-Mineral Self-Supplied	1.00	1.12	1.32	1.51
Mineral Self-Supplied	0.24	0.24	0.24	0.24
Agriculture				
Livestock	0.65	0.65	0.65	0.65
Irrigation	1.84	1.84	1.84	1.84
TOTAL	3.92	4.04	4.25	4.45
	(6.07 cfs)	(6.25 cfs)	(6.58 cfs)	(6.89 cfs)

* Assuming potential low flow conditions.

TABLE 27

FLOWS AT OR BELOW THE 7-DAY 10-YEAR LOW FLOW VALUE
FOR TUNKHANNOCK CREEK NEAR TUNKHANNOCK, PA. DURING PERIOD 1914-1990
(USGS SITE NO. 01534000)

Calendar Year	No. of Days Occurred	Months Occurred/ No. Days Per Month
1930	28	Aug./20, Sep./1, Oct./7
1932	8	Sep./8
1939	1	Jul./1
1941	2	Oct./2
1953	14	Aug./9, Sep./5
1955	2	Aug./2
1962	8	Jul./2, Aug./4, Sep./2
1964	32	Aug./5, Sep./24, Oct./2, Nov./1
1965	5	Jul./5
1966	4	Aug./3, Sep./1
TOTAL	104	Jul./8, Aug./43, Sep./41, Oct./11, Nov./1

FIGURE 7

NUMBER OF DAYS 7-DAY 10-YEAR LOW FLOW OCCURRED DURING PERIOD 1914 – 1990 TUNKHANNOCK CREEK NEAR TUNKHANNOCK, PA.

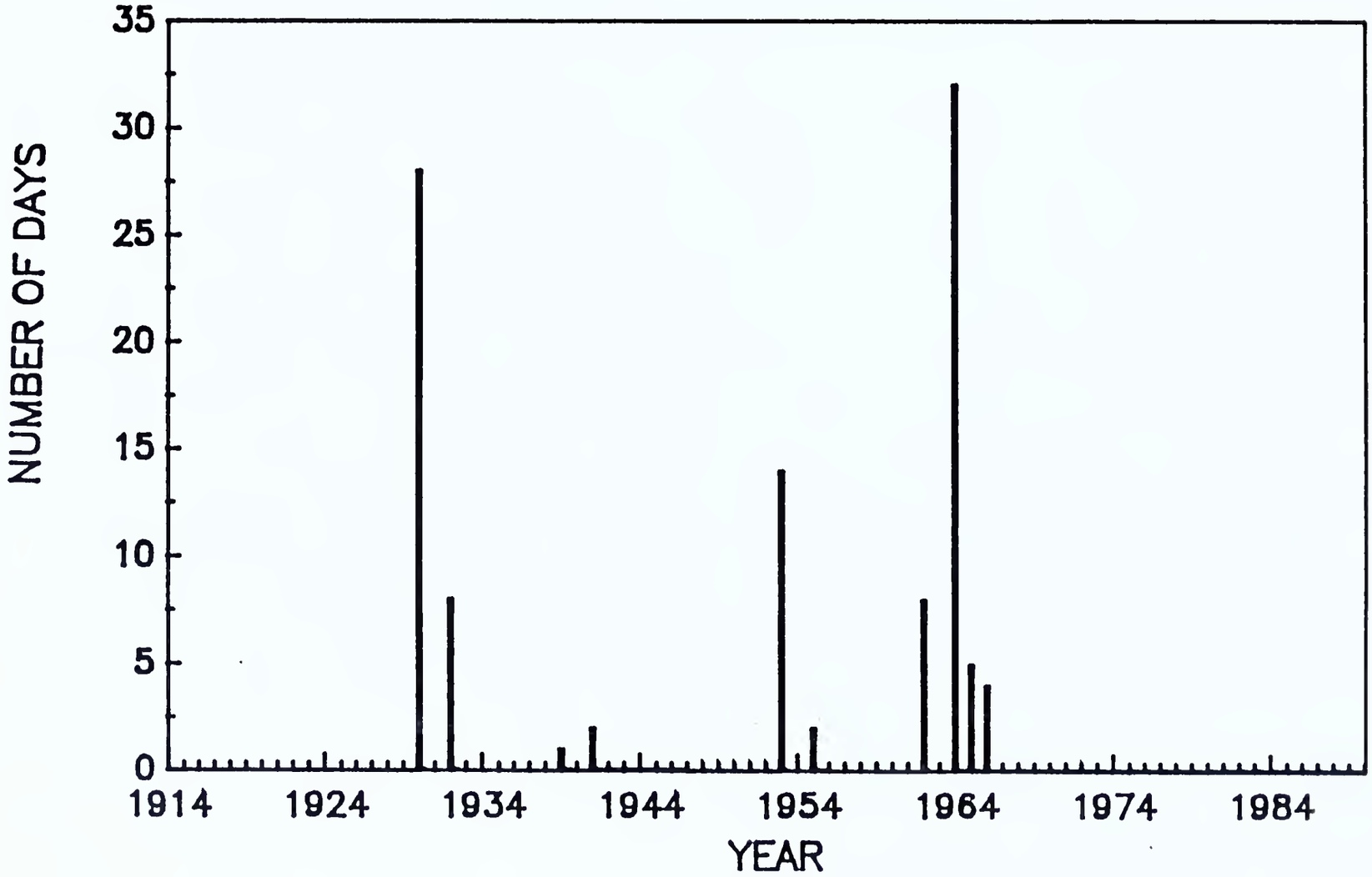
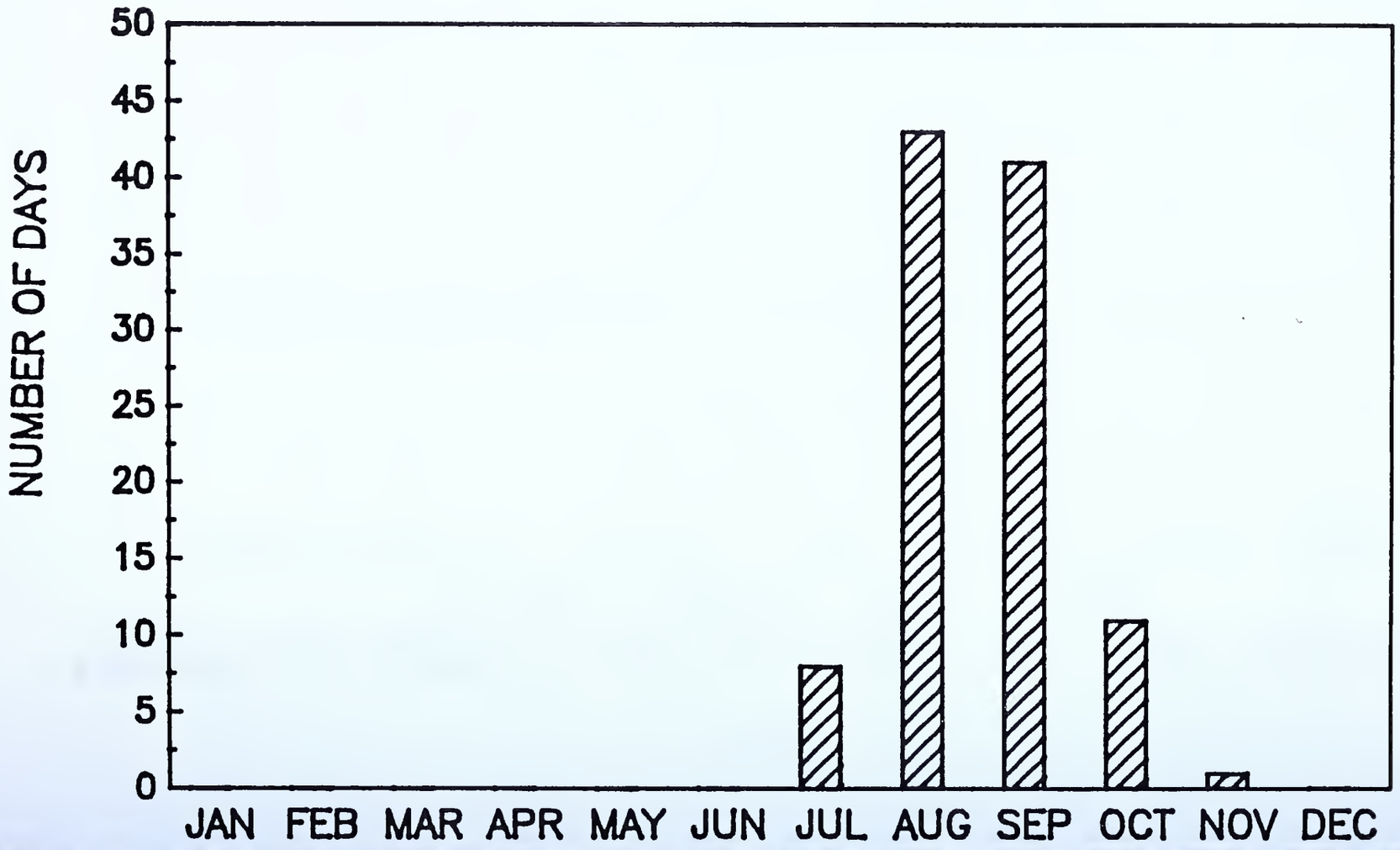


FIGURE 8

NUMBER OF DAYS 7–DAY 10–YEAR LOW FLOW OCCURRED
IN EACH MONTH
TUNKHANNOCK CREEK NEAR TUNKHANNOCK, PA.
(FOR PERIOD 1914 – 1990)



VI. SUBBASIN SECTION 3

LACKAWANNA RIVER

A. WATER USE

1. Municipal Water Use

Baseline water use data for the ten public water suppliers withdrawing water from Section 3 are shown in Table 28. Water use projections are summarized in Table 29. Total water use is expected to decrease from the baseline estimate of 34.69 MGD to 28.13 MGD by 2010. Consumptive use has recently increased from the baseline estimate of 6.94 MGD, but is expected to decrease to 6.11 MGD by 2010.

The above increase in consumptive use was due to startup of the Archbald Power Corporation's electric generation project in 1988. The Archbald project is subject to SRBC consumptive use make-up requirements and was originally approved by the Commission on January 8, 1987. The SRBC approval was modified on March 9, 1989. Water for the project is supplied by the Pennsylvania Gas and Water Company (PG&W). In order to comply with the requirements of the SRBC consumptive use make-up regulation, the project sponsor entered into an agreement with PG&W to release water from PG&W's Heart Lake and Rushbrook Reservoirs. One of the conditions of the SRBC approval specified that plant shutdown would be required if, during a future low flow event, PG&W is unable to supply the water required to satisfy the SRBC consumptive use make-up regulation.

Table 29 includes projections of consumptive use less the Archbald Power Corporation's consumptive use, which will be compensated for by releases from Heart Lake and Rushbrook Reservoirs. This adjusted consumptive use estimate was used to calculate storage estimates presented in Chapter IX of this report.

2. Self-Supplied Non-Mineral Industrial Water Use

Total water demand and consumptive use data for self-supplied non-mineral industries in Section 3 are summarized in Tables 30 and 31. Total use is projected to increase from the baseline estimate of 0.10 MGD to 0.12 MGD by 2010. Although consumptive use is expected to increase slightly, it is projected to be only about 0.01 MGD through the year 2010.

3. Self-Supplied Mineral Industrial Water Use

The Pa. DER reported no self-supplied mineral industries that withdraw water from Section 3.

4. Agricultural Water Use

Total livestock and irrigation water use are estimated to be 0.16 MGD and 1.13 MGD, respectively. Livestock and irrigation consumptive use are estimated to be 0.12 MGD and 0.96 MGD. About 91 percent of the water used for irrigation is used by golf courses. Golf course irrigation estimates are summarized in Table 32.

TABLE 28

BASELINE MUNICIPAL WATER USE DATA FOR SECTION 3
OF THE UPPER SUSQUEHANNA SUBBASIN

Municipal System Name	Source	County	Pop. on System	Avg. Water Use (gpd)	GPCD	Peak Water Use (gpd)	Peak/Avg. Ratio
Chinchilla Water Co.	SW,GW	Lackawanna	544	32,000	58.8	48,000	1.50
Elmbrook Water Co.	GW	Lackawanna	390	30,000	76.9	39,900	1.33
Farview State Hospital*	SW,GW	Wayne		194,200		194,200	
Moscow Water Co.	SW	Lackawanna	581	45,400	78.1	59,928	1.32
Olwen Heights Water Serv. Co.	GW	Lackawanna	524	38,900	74.2	46,291	1.19
Pa. Am. Water Co.** Abington Dist.	GW	Lackawanna	12,066	1,149,700	95.3	1,460,119	1.27
Pa. Gas & Water Co.*** Scranton Div.	SW,GW	Lackawanna	159,891	33,160,207	207.5	37,471,034	1.13
Poco Springs Water Co.	GW	Lackawanna	236	18,000	76.3	25,020	1.39
St. Marys Villa Nursing Home	GW	Lackawanna	200	11,800	59.0	17,700	1.50
Stanton Water Co.	GW	Lackawanna	238	13,000	54.6	14,040	1.08
TOTALS			174,670	34,693,207		39,376,232	

* No population, GPCD, water use projections, or peak value data available.

** Has sources in Sections 2 and 3, with the greater amount of water being withdrawn from Section 3.

*** The Pa. Gas & Water Co. has sources in Section 2, 3 and 4. Most of the Scranton Division is located in Section 3, while most of the Spring Brook Division is in Section 4.

TABLE 29

MUNICIPAL WATER USE PROJECTIONS FOR SECTION 3
OF THE UPPER SUSQUEHANNA SUBBASIN

Parameter	Base	1990	2000	2010
Population Serviced	174,670	162,144	151,517	142,387
Avg. Daily Water* Use (gpd)	34,693,207	32,523,552	30,102,768	28,133,263
Consumptive Use (gpd)*	6,938,641	6,984,710	6,500,554	6,106,653
Peak Water Use (gpd)*	39,376,232	36,871,367	34,153,510	31,938,246
Section Consumptive Use Less the Archbald Power Corp. Consumptive Use**	6,938,641	6,384,710	5,900,554	5,506,653

* 1990-2010 projections include 0.60 MGD total and consumptive use by the Archbald Power Corp. which purchases water from the Pa. Gas & Water Co. Scranton Division. The Archbald Power Corp. project became operational in 1988.

** During low flow conditions, water from the Pa. Gas & Water Co.'s Heart Lake and Rushbrook Reservoirs will be released as make-up for the Archbald Power Corp. consumptive use. Both Heart Lake and Rushbrook Reservoirs are located in Section 3 of the Upper Susquehanna Subbasin.

TABLE 30

NON-MINERAL INDUSTRIAL WITHDRAWALS IN SECTION 3
TOTAL USE

Withdrawal	Source	Base (gpd)	1990 (gpd)	2000 (gpd)	2010 (gpd)
Acker Drill Co.	GW	9,000	9,000	9,000	9,000
Bona Sportsweare Co., Inc.	SW	1,200	1,200	1,200	1,200
Bonarrigo Homecraft	GW	575	575	575	575
City View Press	GW	450	536	617	698
David Elliott	GW	25,400	28,956	32,004	35,052
DSW Tool Co.	GW	425	425	425	425
Elenger Industries	GW	105	105	105	105
Equipment Technology Inc.	GW	1,830	1,830	1,830	1,830
Gentex Corp.	SW	998	1,248	1,527	1,806
Goex Inc. (1)	GW	77	77	77	77
Goex Inc. (2)	SW	16,200	16,200	16,200	16,200
Independent Explosives	GW	1,150	1,150	1,150	1,150
J. B. Dress Co. Inc.	GW	1,050	1,050	1,050	1,050
JDM Materials	GW	6,180	6,180	6,180	6,180
J. M. Willcut Metal Fab	GW	20	20	20	20
Mid-Valley Bottling Co.	SW	2,160	2,462	2,722	2,981
Pa. Hide & Rendering	SW	29,300	33,402	36,918	40,434
Rinaldi Cutting Co.	GW	125	125	125	125
Shoppers Guide	GW	150	179	206	233
TS Number One	GW	36	36	36	36
Wayne Crushed Stone Inc.	GW	3,000	3,000	3,000	3,000
Totals		99,431	107,756	114,967	122,177

TABLE 31

NON-MINERAL INDUSTRIAL WITHDRAWALS IN SECTION 3
CONSUMPTIVE USE

Withdrawal	SIC	Base (gpd)	1990 (gpd)	2000 (gpd)	2010 (gpd)
Acker Drill Co.	35	381	381	381	381
Bona Sportsweare Co. Inc.	23	92	92	92	92
Bonarrigo Homecraft	24	44	44	44	44
City View Press	27	35	41	48	54
David Elliott	20	1,816	2,070	2,288	2,506
DSW Tool Co.	35	18	18	18	18
Elenger Industries	30	5	5	5	5
Equipment Technology Inc.	35	77	77	77	77
Gentex Corp.	38	52	66	80	95
Goex Inc. (1)	28	5	5	5	5
Goex Inc. (2)	28	1,089	1,089	1,089	1,089
Independent Explosives	28	77	77	77	77
J. B. Dress Co. Inc.	23	81	81	81	81
JDM Materials	32	810	810	810	810
J. M. Willcut Metal Fab	34	1	1	1	1
Mid-Valley Bottling Co.	20	154	176	195	213
Pa. Hide & Rendering	20	2,095	2,388	2,640	2,891
Rinaldi Cutting Co.	23	10	10	10	10
Shoppers Guide	27	12	14	16	18
TS Number One	23	3	3	3	3
Wayne Crushed Stone Inc.	32	393	393	393	393
Totals		7,250	7,841	8,353	8,863

TABLE 32

GOLF COURSE WATER USE IN SECTION 3

Withdrawal	Source	Total Use (gpd)	Consumptive Use (gpd)
Marjon Golf Course	SW	30,600	26,010
Scranton Municipal Golf Course	SW	118,000	100,300
Country Club of Scranton	SW	338,000	287,300
Elkview Country Club	SW	188,000	159,800
Elmhurst Country Club(1)	GW	66,700	56,695
Elmhurst Country Club(2)	SW	142,000	120,700
Elmhurst Country Club(3)	SW	142,000	120,700
TOTALS		1,025,300	871,505

5. Summary of Water Use in Subbasin Section 3

Tables 33 and 34 summarize estimates of water use in Section 3 through the year 2010.

B. OCCURRENCE of Q7-10 VALUE

Table 35 and Figures 9 and 10 summarize the occurrence of flows at or below the Q7-10 value for the Lackawanna River at Old Forge, Pa. These values and the determination of days with flows at or below the Q7-10 value are based on the observed records. The SRBC (Jackson, 1985) stated that the records at the Old Forge gage are inconsistent due to changes in mine drainage that occurred in 1962. As a result, substantial amounts of flow bypass the Old Forge gage in comparison to conditions prior to 1962.

TABLE 33

TOTAL WATER USE SUMMARY FOR SECTION 3*

User	Total Use (MGD) Base	1990	2000	2010
Municipal				
Domestic & Industry	34.69	32.52	30.10	28.13
Industrial				
Non-Mineral Self-Supplied	0.10	0.11	0.11	0.12
Mineral Self-Supplied	0.00	0.00	0.00	0.00
Agriculture				
Livestock	0.16	0.16	0.16	0.16
Irrigation	1.13	1.13	1.13	1.13
TOTAL	36.08 (55.83 cfs)	33.92 (52.49 cfs)	31.50 (48.74 cfs)	29.54 (45.71 cfs)

* Assuming potential low flow conditions.

TABLE 34

CONSUMPTIVE WATER USE SUMMARY FOR SECTION 3*

User	Consumptive Use (MGD) Base	1990	2000	2010
Municipal				
Domestic & Industry	6.94	6.98	6.50	6.11
Industrial				
Non-Mineral Self-Supplied	0.01	0.01	0.01	0.01
Mineral Self-Supplied	0.00	0.00	0.00	0.00
Agriculture				
Livestock	0.12	0.12	0.12	0.12
Irrigation	0.96	0.96	0.96	0.96
TOTAL CONSUMPTIVE USE	8.03 (12.43 cfs)	8.07 (12.49 cfs)	7.59 (11.74 cfs)	7.20 (11.14 cfs)
ADJUSTED CONSUMPTIVE USE**	8.03 (12.43 cfs)	7.47 (11.56 cfs)	6.99 (10.82 cfs)	6.60 (10.21 cfs)

* Assuming potential low flow conditions.

** Total consumptive use minus consumptive use by the Archbald Power Corp. This value is used in storage calculations (Chapter IX) since water from storage reservoirs will be released as make-up for the Archbald Power Corp. consumptive use.

TABLE 35

FLOWS AT OR BELOW THE 7-DAY 10-YEAR LOW FLOW VALUE
FOR LACKAWANNA RIVER AT OLD FORGE, PA. DURING PERIOD 1938-1987
(USGS SITE NO. 01536000)

Calendar Year	No. of Days Occurred	Months Occurred/ No. Days Per Month
1961	22	Aug./1, Sep./1, Oct./20
1962	17	Jul./7, Aug./5, Sep./5
1963	24	Oct./19, Nov./5
1964	82	Jul./3, Aug./17, Sep./20, Oct./27 Nov./12, Dec./3
1965	6	Jul./6
1980	36	Sep./16, Oct./19, Nov./1
1982	3	Oct./3
1983	15	Aug./4, Sep./10, Oct./1
TOTAL	205	Jul./16, Aug./27, Sep./52, Oct./89, Nov./18, Dec./3

FIGURE 9

NUMBER OF DAYS 7-DAY 10-YEAR LOW FLOW OCCURRED DURING PERIOD 1938 – 1987 LACKAWANNA RIVER AT OLD FORGE, PA.

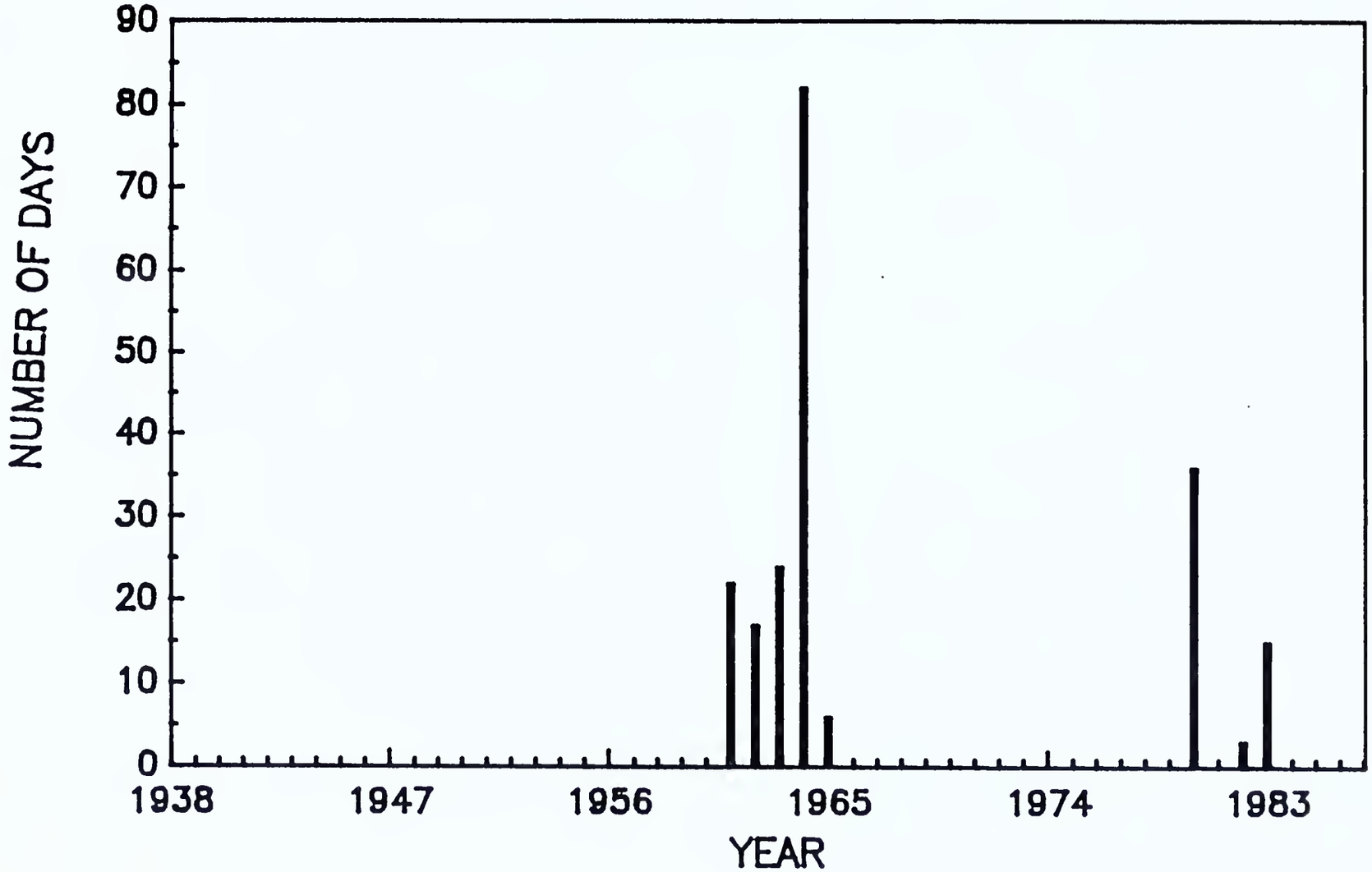
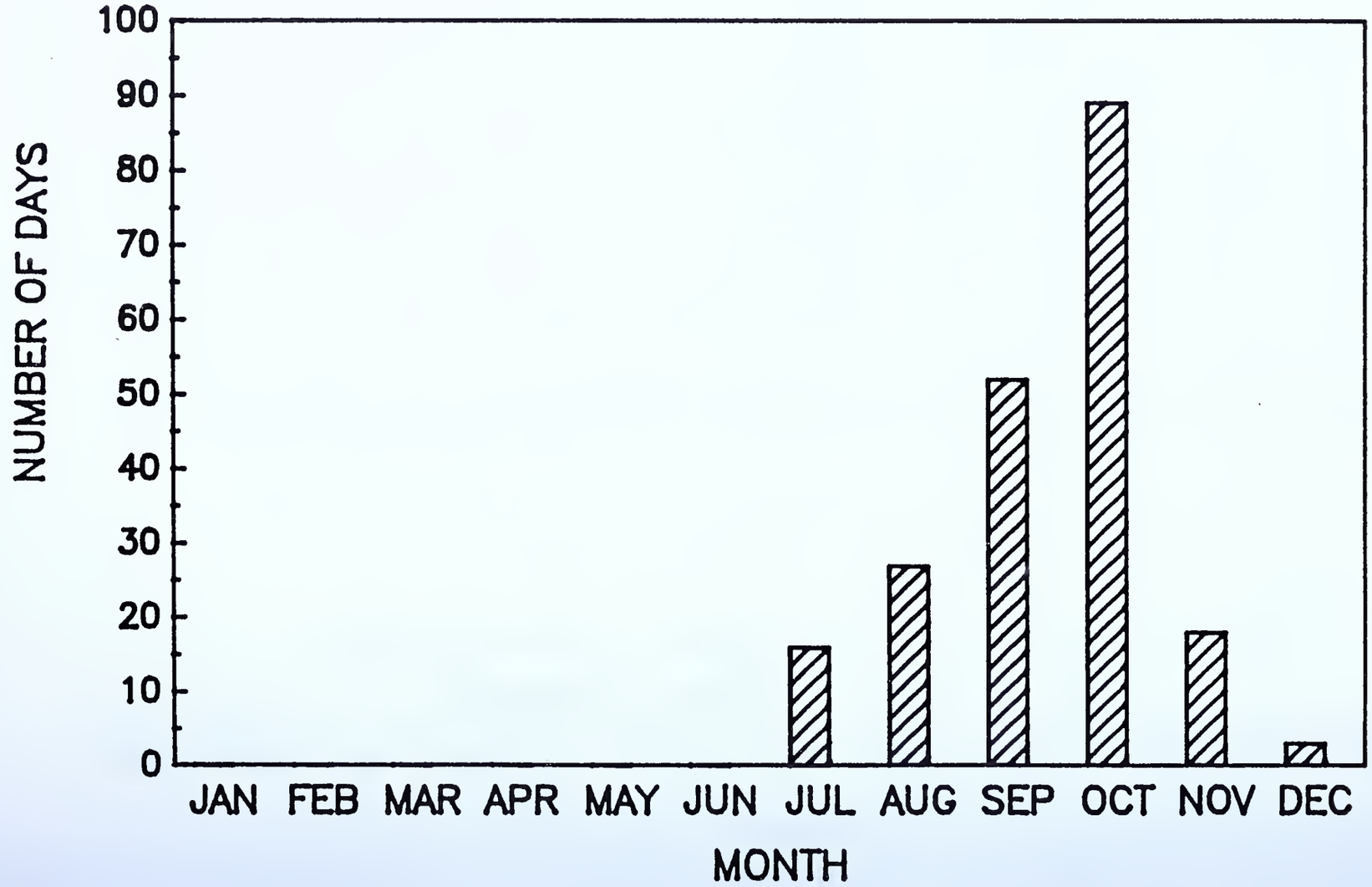


FIGURE 10

NUMBER OF DAYS 7–DAY 10–YEAR LOW FLOW OCCURRED IN EACH MONTH LACKAWANNA RIVER AT OLD FORGE, PA. (FOR PERIOD 1938 – 1987)



VII. SUBBASIN SECTION 4

SUSQUEHANNA RIVER FROM MOUTH OF LACKAWANNA RIVER TO AND INCLUDING WAPWALLOPEN CREEK

A. WATER USE

1. Municipal Water Use

Baseline water use data for the 32 public water suppliers withdrawing water from Section 4 are summarized in Table 36. Water use projections are shown in Table 37. Public systems supply more water from Section 4 than from any other section of the Upper Susquehanna Subbasin. Total water use is expected to decrease from the baseline estimate of 44.48 MGD to 35.47 MGD by 2010. Consumptive use is estimated to be 8.90 MGD under baseline conditions and 7.09 MGD in 2010.

2. Self-Supplied Non-Mineral Industrial Water Use

Total water demand and consumptive use data for self-supplied non-mineral industries in Section 4 are summarized in Tables 38 and 39. More water is withdrawn and used consumptively by self-supplied non-mineral industries in Section 4 than in any other section of the Upper Susquehanna Subbasin. Total water use is projected to increase slightly from the baseline estimate of 105.24 MGD to 105.26 MGD in 2010. Consumptive use is estimated to be 32.50 MGD during baseline conditions and 32.51 MGD in 2010.

The Pennsylvania Power and Light Company's (PP&L's) Susquehanna Steam Electric Station (SSES) near Berwick is subject to the requirements of the SRBC consumptive use make-up

regulation and is the largest consumptive user in the Upper Susquehanna Subbasin. In order to provide make-up water for the project, PP&L, the SRBC, and the U.S. Army Corps of Engineers have entered into contracts to provide storage for the release of water during low flow periods. Storage is provided in the U.S. Army Corps of Engineers Cowanesque Reservoir, located upstream of the SSES on the Cowanesque River in Tioga County, Pa.

Table 39 includes projections of consumptive use less the SSES consumptive use, which will be compensated for by releases from Cowanesque Reservoir. This adjusted consumptive use estimate was used in calculating storage estimates presented in Chapter IX of this report.

3. Self-Supplied Mineral Industrial Water Use

Water use estimates for self-supplied mineral industries in Section 4 are summarized in Tables 40 and 41. Total and consumptive uses are estimated to be 2.27 MGD and 0.18 MGD, respectively, and are projected to remain at these levels through 2010.

4. Agricultural Water Use

Total livestock and irrigation water use are estimated to be 0.12 MGD and 0.85 MGD, respectively. Livestock and irrigation consumptive use are estimated to be 0.09 MGD and 0.72 MGD. About 35 percent of the water used for irrigation is used by golf courses. Golf course irrigation estimates are summarized in Table 42.

TABLE 36

BASELINE MUNICIPAL WATER USE DATA FOR SECTION 4
OF THE UPPER SUSQUEHANNA SUBBASIN

Municipal System Name	Source	County	Pop. on System	Avg. Water Use (gpd)	GPCD	Peak Water Use (gpd)	Peak/Avg. Ratio
Applewood Water Co.	GW	Luzerne	62	3,700	59.7	4,218	1.14
Briarcrest Prop. Owners Assoc.	GW	Luzerne	39	551	14.2	601	1.09
Brown Manor Water Co.	GW	Luzerne	70	11,000	157.3	16,500	1.50
Chase Manor Water Assoc.	GW	Luzerne	143	7,600	53.2	11,400	1.50
Citizens Water Co.	SW	Luzerne	178	7,650	43.0	11,475	1.50
Country Club Apartments	GW	Luzerne	350	17,000	48.6	25,500	1.50
Cross Mtn. View Guest Home*	GW	Luzerne		2,500		2,500	
Dallas State Correctional Institution	GW	Luzerne	1,604	271,000	168.9	284,550	1.05
Dallas Water Co.	GW	Luzerne	4,961	391,000	79.0	500,480	1.28
Garbush Water Co., Inc.	GW	Luzerne	103	5,600	54.4	8,400	1.50
Harveys Lake Water Co.	GW	Luzerne	172	9,020	52.5	13,530	1.50
Hillcrest Water Co.	GW	Luzerne	139	7,060	50.7	18,003	2.55
Hillside Personal Care*	GW	Luzerne		5,400		5,400	
Homesite Water Co.	GW	Luzerne	57	2,500	43.8	3,750	1.50

TABLE 36
(Cont'd)

BASELINE MUNICIPAL WATER USE DATA FOR SECTION 4
OF THE UPPER SUSQUEHANNA SUBBASIN

Municipal System Name	Source	County	Pop. on System	Avg. Water Use (gpd)	GPCD	Peak Water Use (gpd)	Peak/Avg. Ratio
Lakeside Nursing Ctr.*	GW	Luzerne		1,880		1,880	
Maple Hill Nursing Home*	GW	Luzerne		4,000		4,000	
Meadowcrest Water Co.	GW	Luzerne	867	44,900	51.8	67,350	1.50
Meadows Complex	GW	Luzerne	255	20,000	78.4	30,000	1.50
Meadows I.*	GW	Luzerne		2,080		2,080	
Midway Manor Water Co.	GW	Luzerne	373	25,400	68.1	29,972	1.18
Mocanaqua Water Co.	SW	Luzerne	825	72,600	88.0	79,860	1.10
Oak Hill Water Co.	GW	Luzerne	415	30,000	72.3	35,100	1.17
Orchard West Homeowners Assn.*	GW	Luzerne		2,500		2,500	
Overbrook Water Co.	GW	Luzerne	207	17,200	83.1	25,800	1.50
Pa. Gas & Water Co. Spring Brk. Division**	SW,GW	Luzerne	229,490	43,099,300	187.8	50,426,181	1.17
Rhodes Terrace Water Co.	GW	Luzerne	90	6,300	70.0	10,017	1.59
Shavertown Water Co.	GW	Luzerne	2,462	235,600	95.8	292,144	1.24
Shav-Kingston Twp. Water Co.	GW	Luzerne	433	23,100	53.3	33,033	1.43

TABLE 36
(Cont'd)

BASELINE MUNICIPAL WATER USE DATA FOR SECTION 4
OF THE UPPER SUSQUEHANNA SUBBASIN

Municipal System Name	Source	County	Pop. on System	Avg. Water Use (gpd)	GPCD	Peak Water Use (gpd)	Peak/Avg. Ratio
Shickshinny Water Co.	SW	Luzerne	1,190	109,230	91.4	122,338	1.12
Sutton Hills Ltd.	GW	Luzerne	150	13,400	89.3	20,100	1.50
Village Water Co., Inc.*	GW	Luzerne		7,500		7,500	
Worden Place Water Supply	GW	Luzerne	327	24,700	75.5	29,887	1.21
TOTALS			244,962	44,481,271		52,126,049	

* No population, GPCD, water use projections, or peak value data available.
** The Pa. Gas & Water Co. has sources in Sections 2, 3, and 4. Most of the Scranton Division is located in Section 3, while most of the Spring Brook Division is in Section 4.

TABLE 37

MUNICIPAL WATER USE PROJECTIONS FOR SECTION 4
OF THE UPPER SUSQUEHANNA SUBBASIN

Parameter	Base	1990	2000	2010
Population Served	244,962	225,710	207,819	196,944
Avg. Daily Water Use (gpd)	44,481,271	40,844,029	37,506,302	35,473,420
Consumptive Use (gpd)	8,896,254	8,168,806	7,501,260	7,094,684
Peak Water Use (gpd)	52,126,049	47,875,630	43,969,900	41,590,388

TABLE 38

NON-MINERAL INDUSTRIAL WITHDRAWALS IN SECTION 4
TOTAL USE

Withdrawal	Source	Base (gpd)	1990 (gpd)	2000 (gpd)	2010 (gpd)
Andreas Lumber Inc.	SW	140	140	140	140
CV Products	GW	208	208	208	208
Columbia Porch Shade Co. Inc.	GW	175	229	247	264
Country Cousins Shoes	GW	240	240	240	240
Karen Mfg. Co. Inc.	GW	1,550	1,550	1,550	1,550
Native Textiles	GW	5,510	5,510	5,510	5,510
Offset Paperback Mfrs.	GW	34,400	40,936	47,128	53,320
PP&L Susquehanna Steam Elec. Station*	SW	56,200,000	56,200,000	56,200,000	56,200,000
Precision Tool & Machine Co.	GW	200	200	200	200
Ronnie Dress Co.	GW	1,040	1,040	1,040	1,040
Tex Wilson Lumber Co.	GW	75	75	75	75
UGI Hunlock Plant*	SW	49,000,000	49,000,000	49,000,000	49,000,000
Totals		105,243,538	105,250,128	105,256,338	105,262,547

* From Susquehanna River Basin Electric Utilities Group (1987) and SRBC staff investigations.

TABLE 39

NON-MINERAL INDUSTRIAL WITHDRAWALS IN SECTION 4
CONSUMPTIVE USE

Withdrawal	SIC	Base (gpd)	1990 (gpd)	2000 (gpd)	2010 (gpd)
Andreas Lumber Inc.	24	11	11	11	11
CV Products	32	27	27	27	27
Columbia Porch Shade Co. Inc.	25	0	0	0	0
Country Cousins Shoes	30	12	12	12	12
Karen Mfg. Co. Inc.	23	119	119	119	119
Native Textiles	22	645	645	645	645
Offset Paperback Mfrs.	27	2,649	3,152	3,629	4,106
PP&L Susquehanna Steam Elec. Station*	49	32,200,000	32,200,000	32,200,000	32,200,000
Precision Tool & Machine Co.	35	8	8	8	8
Ronnie Dress Co.	23	80	80	80	80
Tex Wilson Lumber Co.	24	6	6	6	6
UGI Hunlock Plant*	49	300,000	300,000	300,000	300,000
Totals		32,503,557	32,504,060	32,504,537	32,505,014
Section Consumptive Use Less the Susquehanna Steam Elec. Station Consumptive Use**		32,503,557	304,060	304,537	305,014

* From Susquehanna River Basin Electric Utilities Group (1987) and SRBC staff investigations.

** During low flow conditions after early 1990, water from the U.S. Army Corps of Engineers Cowanesque Reservoir will be released as make-up for the PP&L Susquehanna Steam Electric Station's consumptive use. Cowanesque Reservoir is located upstream on the Cowanesque River in Tioga County, Pa.

TABLE 40

MINERAL INDUSTRIAL WITHDRAWALS IN SECTION 4
TOTAL USE

Withdrawal	Source	Base (gpd)	1990 (gpd)	2000 (gpd)	2010 (gpd)
American Asphalt Paving(1)	SW	6,040	6,040	6,040	6,040
American Asphalt Paving(2)	GW	52	52	52	52
American Asphalt Paving(3)	SW	105	105	105	105
Coolbaugh Sand & Stone	SW	1,820	1,820	1,820	1,820
Emerald Anthracite	GW	975,000	975,000	975,000	975,000
Kaminski Bros.	GW	14,400	14,400	14,400	14,400
Prospect Colliery	GW	1,130,000	1,130,000	1,130,000	1,130,000
Silverbrook Anthracite	SW	3,600	3,600	3,600	3,600
Silverbrook Coal	GW	5,000	5,000	5,000	5,000
West Wyoming Pit	SW	134,000	134,000	134,000	134,000
TOTALS		2,270,017	2,270,017	2,270,017	2,270,017

TABLE 41

MINERAL INDUSTRIAL WITHDRAWALS IN SECTION 4
CONSUMPTIVE USE

Withdrawal	SIC	Base (gpd)	1990 (gpd)	2000 (gpd)	2010 (gpd)
American Asphalt Paving(1)	1,442	315	315	315	315
American Asphalt Paving(2)	1,442	3	3	3	3
American Asphalt Paving(3)	1,442	5	5	5	5
Coolbaugh Sand & Stone	1,429	122	122	122	122
Emerald Anthracite	1,111	77,903	77,903	77,903	77,903
Kaminski Bros.	1,111	1,151	1,151	1,151	1,151
Prospect Colliery	1,111	90,287	90,287	90,287	90,287
Silverbrook Anthrcite	1,111	288	288	288	288
Silverbrook Coal	1,111	400	400	400	400
West Wyoming Pit	1,442	6,995	6,995	6,995	6,995
TOTALS		177,469	177,469	177,469	177,469

TABLE 42

GOLF COURSE WATER USE IN SECTION 4

Withdrawal	Source	Total Use (gpd)	Consumptive Use (gpd)
Farley's Sweet Water	GW	20,400	17,340
Irem Temple Country Club	GW	81,500	69,275
Wyoming Valley Country Club	SW	150,000	127,500
Jean's Run Golf Club	SW	42,800	36,380
TOTALS		294,700	250,495

5. Summary of Water Use in Subbasin Section 4

Tables 43 and 44 summarize estimates of water use in Section 4 through the year 2010. Total and consumptive water use are greater in Section 4 than in any other section of the Upper Susquehanna Subbasin.

B. OCCURRENCE OF Q7-10 VALUE

Table 45 and Figures 11 and 12 summarize the occurrence of flows at or below the Q7-10 value for the Susquehanna River at Wilkes-Barre, Pa. Flows at or below the Q7-10 value have been reported in July, August, September, October, and November of various years. Flows of this magnitude occurred during more days in 1964 than in any other year of record.

TABLE 43

TOTAL WATER USE SUMMARY FOR SECTION 4*

User	Total Use (MGD) Base	1990	2000	2010
Municipal				
Domestic & Industry	44.48	40.84	37.51	35.47
Industrial				
Non-Mineral Self-Supplied	105.24	105.25	105.26	105.26
Mineral Self-Supplied	2.27	2.27	2.27	2.27
Agriculture				
Livestock	0.12	0.12	0.12	0.12
Irrigation	0.85	0.85	0.85	0.85
TOTAL	152.96	149.33	146.01	143.97
	(236.68 cfs)	(231.06 cfs)	(225.93 cfs)	(222.77 cfs)

* Assuming potential low flow conditions.

TABLE 44

CONSUMPTIVE WATER USE SUMMARY FOR SECTION 4*

User	Consumptive Use (MGD) Base	1990	2000	2010
Municipal				
Domestic & Industry	8.90	8.17	7.50	7.09
Industrial				
Non-Mineral Self-Supplied	32.50	32.50	32.50	32.51
Mineral Self-Supplied	0.18	0.18	0.18	0.18
Agriculture				
Livestock	0.09	0.09	0.09	0.09
Irrigation	0.72	0.72	0.72	0.72
TOTAL	42.39	41.66	40.99	40.59
	(65.59 cfs)	(64.46 cfs)	(63.43 cfs)	(62.81 cfs)
ADJUSTED CONSUMPTIVE USE**	42.39	9.46	8.79	8.39
	(65.59 cfs)	(14.64 cfs)	(13.60 cfs)	(12.98 cfs)

* Assuming potential low flow conditions.

** Total consumptive use minus consumptive use by the SSES. This value is used in storage calculations (Chapter IX) since water from Cowanesque Reservoir will be released as make-up for the SSES consumptive use.

TABLE 45

FLOWS AT OR BELOW THE 7-DAY 10-YEAR LOW FLOW VALUE
FOR THE SUSQUEHANNA RIVER AT WILKES-BARRE, PA. DURING PERIOD 1899-1988
(USGS SITE NO. 01536500)

Calendar Year	No. of Days Occurred	Months Occurred/ No. Days Per Month
1900	3	Sep./1, Oct./2
1908	12	Sep./12
1911	3	Aug./3
1939	29	Aug./6, Sep./23
1941	14	Sep./5, Oct./9
1953	4	Sep./1, Oct./3
1955	10	Jul./1, Aug./9
1959	7	Sep./7
1962	30	Aug./7, Sep./23
1963	25	Oct./19, Nov./6
1964	96	Aug./12, Sep./28, Oct./31, Nov./25
1965	2	Jul./2
TOTAL	235	Jul./3, Aug./37, Sep./100, Oct./64, Nov./31

FIGURE 11

NUMBER OF DAYS 7-DAY 10-YEAR LOW FLOW OCCURRED
DURING PERIOD 1899 – 1988
SUSQUEHANNA RIVER AT WILKES-BARRE, PA.

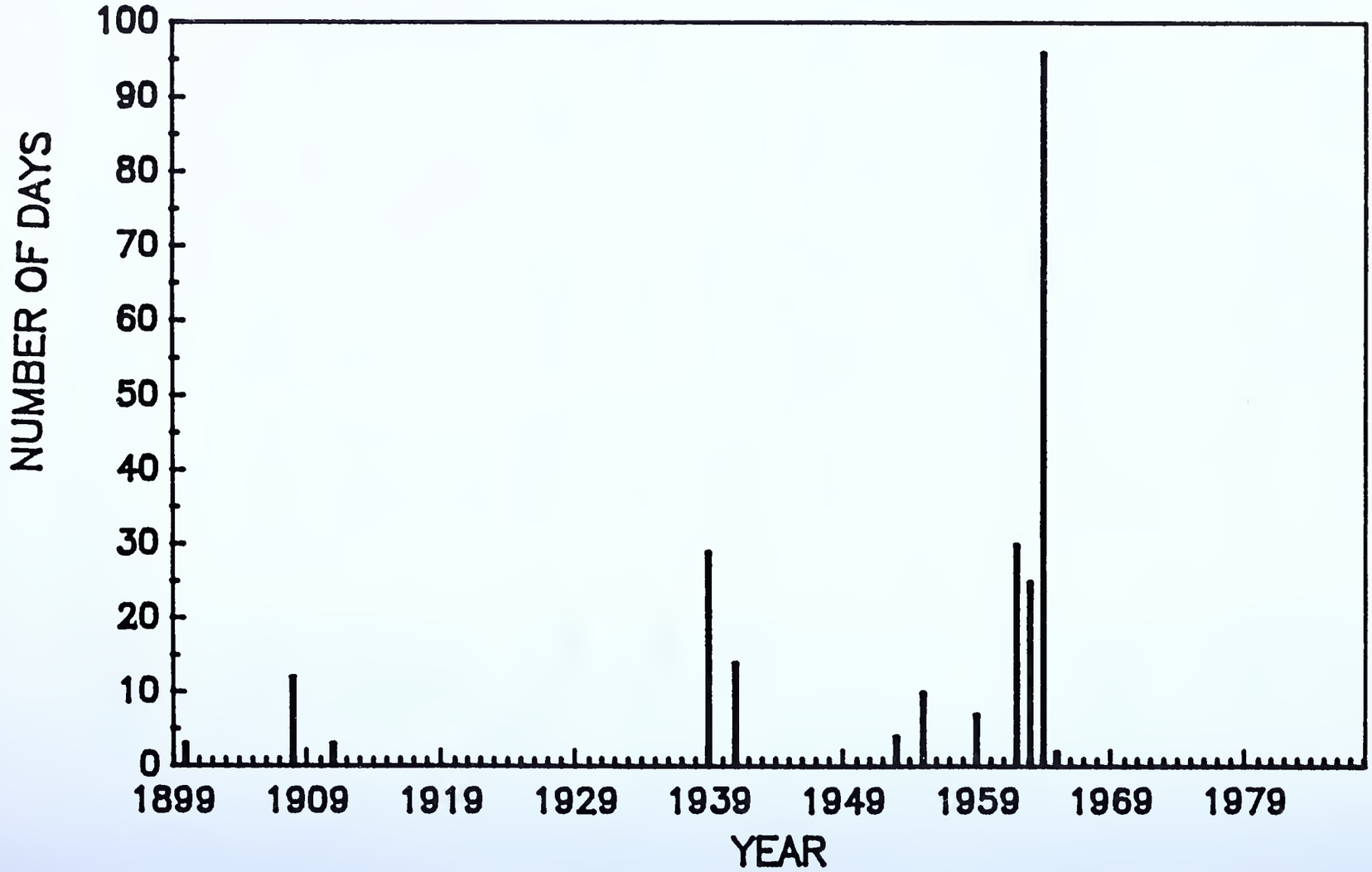
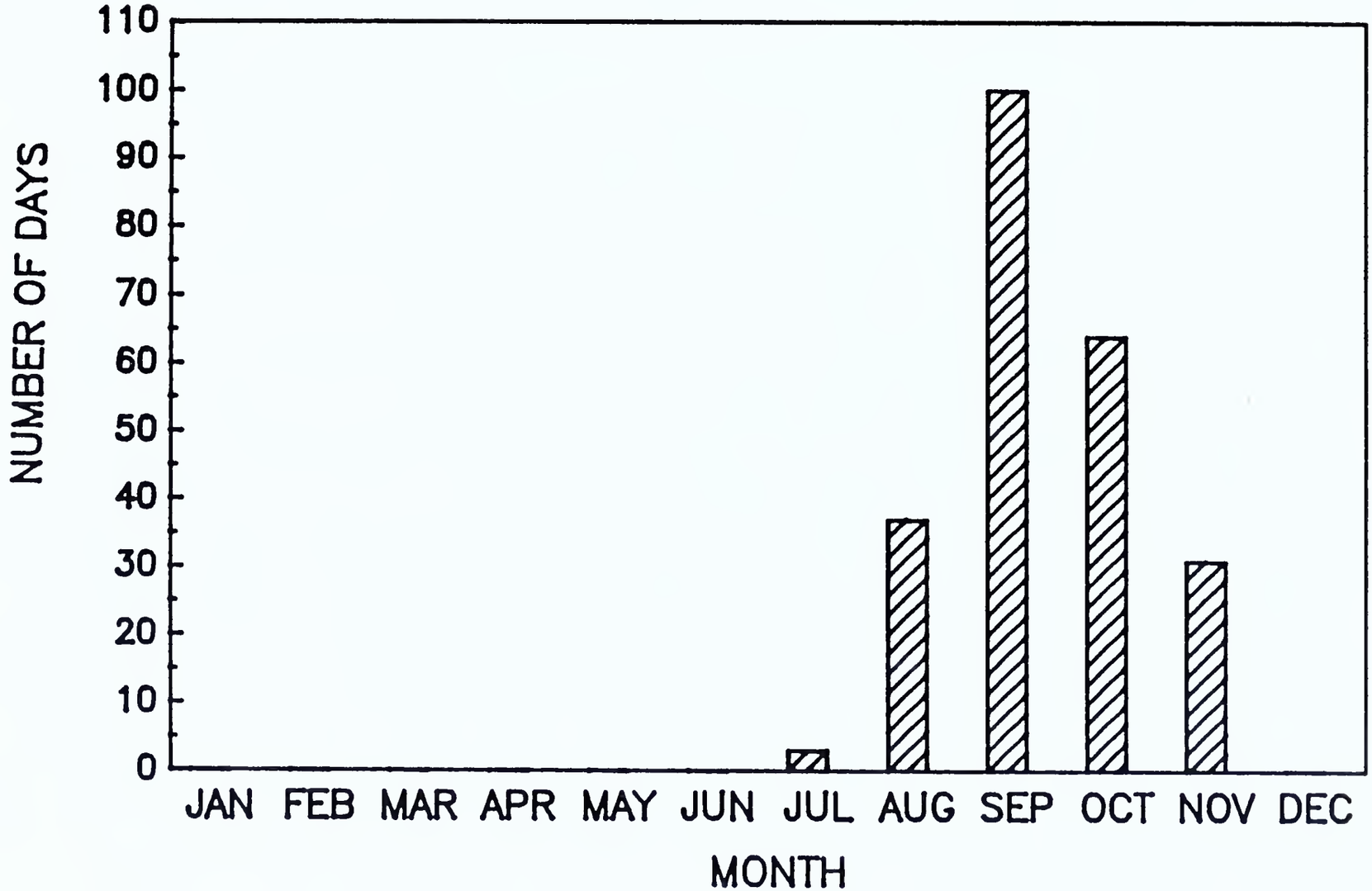


FIGURE 12

NUMBER OF DAYS 7–DAY 10–YEAR LOW FLOW OCCURRED IN EACH MONTH SUSQUEHANNA RIVER AT WILKES–BARRE, PA. (FOR PERIOD 1899 – 1988)



VIII. SUBBASIN SECTION 5

SUSQUEHANNA RIVER FROM MOUTH OF WAPWALLOPEN CREEK TO MOUTH OF WEST BRANCH SUSQUEHANNA RIVER

A. WATER USE

1. Municipal Water Use

Baseline water use data for the 32 public water suppliers withdrawing water from Section 5 are summarized in Table 46. Water use projections are shown in Table 47. Total water use is expected to decrease from the baseline estimate of 21.84 MGD to 18.92 MGD by 2010. Consumptive use has increased from the baseline estimate of 4.37 MGD, and is estimated to be 5.09 MGD in 1990. Consumptive use is projected to decrease to 4.63 by 2010.

The above increase in consumptive use is due to startup of both the Continental Energy Associates coal gassification and cogeneration facility and the Foster Wheeler Mt. Carmel cogeneration facility in 1989. The Continental Energy Associates project purchases water from CAN DO Inc., while the Foster Wheeler Mt. Carmel project purchases water from the Roaring Creek Water Company. Both projects are subject to the requirements of the SRBC consumptive use make-up regulation. Foster Wheeler Mt. Carmel is in compliance with the regulation since it uses water from a public supplier using raw water storage that maintains a conservation release of the Q7-10 flow or greater at the point of taking as per Commission Regulation 803.61(c)(1)(iv)(e). Continental Energy Associates has not found a source of make-up water and is making interim payments for its consumptive use.

TABLE 46

BASELINE MUNICIPAL WATER USE DATA FOR SECTION 5
OF THE UPPER SUSQUEHANNA SUBBASIN

Municipal System Name	Source	County	Pop. on System	Avg. Water Use (gpd)	GPCD	Peak Water Use (gpd)	Peak/Avg. Ratio
Beaver Brook Water Co.	GW	Luzerne	164	10,900	66.4	16,350	1.50
Benton Municipal Water Auth.	GW	Columbia	1,089	72,000	66.1	100,080	1.39
Bloomsburg Water Co.	GW	Columbia	14,931	1,961,500	131.3	3,393,395	1.73
Boone Nursing Home*	GW	Columbia		2,300		2,300	
Butler Valley Manor*	GW	Luzerne		3,450		3,450	
CAN DO Inc.**	GW	Luzerne		104,110		156,165	1.50
Catawissa Mun. Auth.	SW,GW	Columbia	1,568	150,000	95.7	225,000	1.50
Conyngham Water Co.	GW	Luzerne	2,380	216,600	91.2	288,078	1.33
Danville Boro Mun. Auth.	SW	Montour	7,391	2,016,000	272.3	2,903,040	1.44
Freeland Mun. Auth.	GW	Luzerne	5,201	280,300	53.8	336,360	1.20
Geisinger Medical Ctr.*	SW,GW	Montour		115,000		115,000	
Hazleton Water Auth.***	SW,GW	Luzerne	40,711	5,705,770	140.1	8,558,655	1.50
Honeybrook Water Co.	SW,GW	Schuylkill	5,927	886,000	149.5	1,293,560	1.46
Indian Springs Water Co.	SW	Luzerne	161	11,300	70.1	16,950	1.50
Keystone Job Corps Ctr.*	GW	Luzerne		90,400		90,400	

TABLE 46
(Cont'd)

BASELINE MUNICIPAL WATER USE DATA FOR SECTION 5
OF THE UPPER SUSQUEHANNA SUBBASIN

Municipal System Name	Source	County	Pop. on System	Avg. Water Use (gpd)	GPCD	Peak Water Use (gpd)	Peak/Avg. Ratio
Klingerman Nursing Ctr.*	GW	Columbia		3,660		3,660	
Mahoning Twp. Mun. Auth.	GW	Montour	1,370	329,000	240.2	667,870	2.03
Merck & Co. Inc.	SW	Northumber-land	38	258,000	6,737.1	864,300	3.35
Mifflin Twp. Water Auth.	GW	Columbia	1,028	91,000	88.5	139,230	1.53
Millville Mun. Water Auth.	GW	Columbia	878	85,100	97.0	173,604	2.04
Milnesville No. 7 Water Assoc.	GW	Luzerne	63	3,750	59.8	5,625	1.50
Nuremberg Water Co.	GW	Schuylkill	481	24,730	51.4	29,923	1.21
Oneida Water Co.	GW	Schuylkill	488	40,000	82.0	60,000	1.50
Orangeville Boro Water Auth.	SW,GW	Columbia	497	31,300	63.0	34,117	1.09
Pardeesville Water Assoc.	GW	Luzerne	204	10,000	49.0	13,000	1.30
Pa. Am. Water Co. Berwick Dist.	SW,GW	Columbia	17,733	3,054,200	172.0	3,420,704	1.12
Red Rock Job Corps Ctr.*	GW	Luzerne		33,340		33,340	
Ringtown Boro Mun. Auth.	SW,GW	Schuylkill	901	143,300	158.7	214,950	1.50

TABLE 46
(Cont'd)

BASELINE MUNICIPAL WATER USE DATA FOR SECTION 5
OF THE UPPER SUSQUEHANNA SUBBASIN

Municipal System Name	Source	County	Pop. on System	Avg. Water Use (gpd)	GPCD	Peak Water Use (gpd)	Peak/Avg. Ratio
Roaring Crk. Water Co. ***	SW,GW	Northumber-land	29,532	3,716,280	125.8	5,611,583	1.51
Scenic Knoll Water Co.	GW	Columbia	138	10,000	72.4	12,000	1.20
Shenandoah Mun. Water Auth.***	SW	Schuylkill	11,100	2,353,100	211.7	3,153,154	1.34
Wonderview Waterworks, Inc.	GW	Columbia	347	28,790	83.0	29,942	1.04
TOTALS			144,321	21,841,180		31,965,785	

* No population, GPCD, water use projections, or peak value data available.

** Supplies a total of 17 customers, which are all industries at the Humboldt Industrial Park. Peak/average ratio was assumed to be 1.50.

*** Also have sources outside the Upper Susquehanna Subbasin. The Hazleton Water Authority was recently searching for additional sources of water supply. They considered applying to the Pa. DER for a 6 MGD withdrawal from the Susquehanna River. As of March 1, 1990, they had filed an application with the Pa. DER for the withdrawal of 6 MGD from the Lehigh River and 1.0 MGD from Wetzel Creek, both in the Delaware River Basin.

TABLE 47

MUNICIPAL WATER USE PROJECTIONS FOR SECTION 5
OF THE UPPER SUSQUEHANNA SUBBASIN

Parameter	Base	1990	2000	2010
Population Served	144,321	133,353	123,659	117,888
Avg. Daily Water* Use (gpd)	21,841,180	21,224,790	19,768,780	18,922,610
Consumptive Use (gpd)*	4,368,236	5,088,158	4,796,956	4,627,722
Peak Water Use (gpd)*	31,965,785	30,605,765	28,475,696	27,224,211

* 1990-2010 projections include 0.214 MGD total and consumptive use by Continental Energy Associates and 0.84 MGD total and consumptive use by Foster Wheeler Mt. Carmel. These companies are new consumptive users withdrawing water from municipal systems.

2. Self-Supplied Non-Mineral Industrial Water Use

Total water demand and consumptive use data for self-supplied non-mineral industries in Section 5 are summarized in Tables 48 and 49. Total use is projected to increase from the baseline estimate of 8.75 MGD to 11.76 MGD by 2010. Consumptive use is estimated to be 0.67 MGD under baseline conditions and 3.46 MGD in 2010. Two new water users are subject to the requirements of the SRBC consumptive use make-up regulation. Pagnotti Enterprises, Inc. has proposed construction of a cogeneration facility that would use and consume up to 2.5 MGD of water from an underground mine pool. The SRBC granted interim approval for the Pagnotti project on November 13, 1986, and took further interim approval action on February 11, 1988. The project is not yet in operation and the applicant does not presently have a source of make-up water. When the project becomes operational, the project sponsor is required to make interim payments to the SRBC for the project's consumptive use if a source of make-up water has not been approved by the SRBC.

The Viking Energy of Northumberland Limited Partnership's wood-fired cogeneration plant became operational in 1989. The project was first approved by the SRBC on March 12, 1987. The SRBC took further approval action concerning the project on April 14, 1988 and November 10, 1988. In order to comply with the requirements of the SRBC consumptive use make-up regulation, Viking has entered into a contract with Red Run Mountain Realty Partnership to supply make-up water from a reservoir on Red Run,

located near Ralston, Lycoming County, Pa. Red Run is a tributary of Lycoming Creek, which flows into the West Branch Susquehanna River.

3. Self-Supplied Mineral Industrial Water Use

Water use estimates for self-supplied mineral industries in Section 5 are summarized in Tables 50 and 51. Total and consumptive uses are estimated to be 3.21 MGD and 0.24 MGD, respectively, and are projected to remain at these levels through 2010.

4. Agricultural Water Use

Total livestock and irrigation water use are estimated to be 0.54 MGD and 2.89 MGD, respectively. Livestock and irrigation consumptive use are estimated to be 0.40 MGD and 2.45 MGD. Irrigation water use is greater in Section 5 than in any other section of the subbasin. About 49 percent of the water used for irrigation is used by golf courses. Golf course irrigation estimates are summarized in Table 52.

5. Summary of Water Use in Subbasin Section 5

Tables 53 and 54 summarize estimates of water use in Section 5 through the year 2010.

B. OCCURRENCE OF Q7-10 VALUE

Table 55 and Figures 13 and 14 summarize the occurrence of flows at or below the Q7-10 value for the Susquehanna River at

TABLE 48

NON-MINERAL INDUSTRIAL WITHDRAWALS IN SECTION 5
TOTAL USE

Withdrawal	Source	Base (gpd)	1990 (gpd)	2000 (gpd)	2010 (gpd)
A. Barletta & Sons	SW	108,000	108,000	108,000	108,000
A&E Ringtown	GW	33,200	33,200	33,200	33,200
Aronson Mfg. Corp.	GW	840	840	840	840
Audimation Corp.	GW	12	12	12	12
Benton Foundry Inc.	GW	24,000	24,000	24,000	24,000
Berwick Industries	GW	357	357	357	357
Biros Railing	GW	4	4	4	4
Bloomsburg Carpet	GW	5,340	5,340	5,340	5,340
Bloomsburg Mills	GW	338,000	338,000	338,000	338,000
Boston Farm Products	GW	250	285	315	345
Brandt Mills Inc.	GW	212	242	267	293
Briar Knitting Mills	GW	200	200	200	200
Brockman Sheet Metal(1)	SW	40	40	40	40
Brockman Sheet Metal(2)	SW	40	40	40	40
Catawissa Lumber	GW	406	406	406	406
Central Builders	GW	5,960	5,960	5,960	5,960
Champion Valley	GW	173,000	197,220	217,980	238,740
Charles Bruce	GW	2	2	2	2
Charles D. Roberts	GW	165	165	165	165
Chromatex Inc.	GW	877	877	877	877
College Casuals Co. Inc.	GW	6	6	6	6
Columbia Asphalt(1)	GW	417	417	417	417
Columbia Asphalt(2)	SW	2,080	2,080	2,080	2,080
Columbia Graphics	GW	20	24	27	31
Consolidated Cigar	GW	261,000	261,000	261,000	261,000
Corenco Corp.	GW	496	565	625	684
Country Maid Sportswear	GW	2,500	2,500	2,500	2,500
Custom Metal Products Inc.	GW	100	100	100	100
Deihl Vault & Precast	GW	1,600	1,600	1,600	1,600
Del-Bar Sheet Metal Co.	GW	76	76	76	76
Farmers Co-Op Dairy	GW	22,300	25,422	28,098	30,774
Farr Brothers Lumber	GW	150	150	150	150
Feeser Supply Co.	GW	3,560	3,560	3,560	3,560
Front Street Fashions	GW	45	45	45	45
Genova Inc.	GW	10,300	10,300	10,300	10,300
Girton Mfg. Co. Inc.	SW	3,760	3,760	3,760	3,760
Harold C. Schneider	GW	1	1	1	2
Hazel Park Packing	GW	2,200	2,508	2,772	3,036
Hazleton Brick Co.	GW	20	20	20	20
Hilla's Fashions	GW	500	500	500	500
Hock Transit Mix	GW	1,020	1,020	1,020	1,020
Holoviak's Publishing	GW	30	36	41	47
IA Construction	GW	1,250	1,250	1,250	1,250
Janeczek Bros. Wayside Fm.D.	GW	3,000	3,420	3,780	4,140
Johnson's Mill	GW	30	34	38	41

TABLE 48
(Cont'd)

NON-MINERAL INDUSTRIAL WITHDRAWALS IN SECTION 5
TOTAL USE

Withdrawal	Source	Base (gpd)	1990 (gpd)	2000 (gpd)	2010 (gpd)
Joseph Gorski Machine Shop	GW	300	300	300	300
Merck & Co.	SW	7,050,000	7,050,000	7,050,000	7,050,000
Millville Products	GW	15	15	15	15
National Select	GW	648,000	648,000	648,000	648,000
Pagnotti Enterprises, Inc. (Hazleton Cogen)*	GW	0	0	2,500,000	2,500,000
Poloron Products	GW	27,700	27,700	27,700	27,700
Princeton Pkg. Inc.	GW	5,480	6,138	7,234	8,330
Robert W. Hart & Son Inc.	GW	10	10	10	10
S&B Foundry Co.	GW	4,000	4,000	4,000	4,000
Schultz Electroplating	GW	300	300	300	300
Sharp Precision Tool & Die Co.	GW	1	1	1	1
TRW Inc.	GW	4,800	4,800	4,800	4,800
Wilkes Pool Corp.	GW	375	375	375	375
Viking Energy*	GW	0	432,000	432,000	432,000
Totals		8,748,347	9,209,223	11,734,506	11,759,791

* Based on SRBC Project Review Files (Sept. 1989).

TABLE 49

NON-MINERAL INDUSTRIAL WITHDRAWALS IN SECTION 5
CONSUMPTIVE USE

Withdrawal	SIC	Base (gpd)	1990 (gpd)	2000 (gpd)	2010 (gpd)
A. Barletta & Sons	32	14,148	14,148	14,148	14,148
A&E Ringtown	30	1,723	1,723	1,723	1,723
Aronson Mfg. Corp.	23	65	65	65	65
Audimation Corp.	36	1	1	1	1
Benton Foundry Inc.	33	1,481	1,481	1,481	1,481
Berwick Industries	22	42	42	42	42
Biros Railing	34	0	0	0	0
Bloomsburg Carpet	22	625	625	625	625
Bloomsburg Mills	22	39,546	39,546	39,546	39,546
Boston Farm Products	20	18	20	23	25
Brandt Mills Inc.	20	15	17	19	21
Briar Knitting Mills	22	23	23	23	23
Brockman Sheet Metal(1)	34	2	2	2	2
Brockman Sheet Metal(2)	34	2	2	2	2
Catawissa Lumber	24	31	31	31	31
Central Builders	32	781	781	781	781
Champion Valley	20	12,370	14,101	15,586	17,070
Charles Bruce	24	0	0	0	0
Charles D. Roberts	24	13	13	13	13
Chromatex Inc.	22	103	103	103	103
College Casuals Co. Inc.	23	0	0	0	0
Columbia Asphalt(1)	29	63	63	63	63
Columbia Asphalt(2)	29	316	316	316	316
Columbia Graphics	27	2	2	2	2
Consolidated Cigar	21	43,587	43,587	43,587	43,587
Corenco Corp.	20	35	40	45	49
Country Maid Sportswear	23	193	193	193	193
Custom Metal Products Inc.	34	4	4	4	4
Deihl Vault & Precast	32	210	210	210	210
Del-Bar Sheet Metal Co.	34	3	3	3	3
Farmers Co-Op Dairy	20	1,594	1,818	2,009	2,200
Farr Brothers Lumber	24	12	12	12	12
Feeser Supply Co.	32	466	466	466	466
Front Street Fashions	23	3	3	3	3
Genova Inc.	30	535	535	535	535
Girton Mfg. Co. Inc.	35	159	159	159	159
Harold C. Schneider	27	0	0	0	0
Hazel Park Packing	20	157	179	198	217
Hazleton Brick Co.	32	3	3	3	3
Hilla's Fashions	23	39	39	39	39
Hock Transit Mix	32	134	134	134	134
Holoviak's Publishing	27	2	3	3	4
IA Construction	29	190	190	190	190
Janeczek Bros. Wayside Fm.D.	20	215	245	270	296
Johnson's Mill	20	2	2	3	3

TABLE 49
(Cont'd)

NON-MINERAL INDUSTRIAL WITHDRAWALS IN SECTION 5
CONSUMPTIVE USE

Withdrawal	SIC	Base (gpd)	1990 (gpd)	2000 (gpd)	2010 (gpd)
Joseph Gorski Machine Shop	35	13	13	13	13
Merck & Co.	28	473,760	473,760	473,760	473,760
Millville Products	34	1	1	1	1
National Select	22	75,816	75,816	75,816	75,816
Pagnotti Enterprises, Inc. (Hazleton Cogen)*	49	0	0	2,500,000	2,500,000
Poloron Products	34	1,222	1,222	1,222	1,222
Princeton Pkg. Inc.	26	424	474	559	644
Robert W. Hart & Son Inc.	34	0	0	0	0
S&B Foundry Co.	33	247	247	247	247
Schultz Electroplating	34	13	13	13	13
Sharp Precision Tool & Die Co.	35	0	0	0	0
TRW Inc.	37	307	307	307	307
Wilkes Pool Corp.	35	16	16	16	16
Viking Energy*	49	0	288,000	288,000	288,000
Totals		670,732	960,799	3,462,615	3,464,429
Section Consumptive Use Less the Viking Energy Consumptive Use**		670,732	672,799	3,174,615	3,176,429

* Based on SRBC Project Review Files (Sept. 1989).

** During low flow conditions, water from a reservoir on Red Run, Lycoming County, Pa will be released as make-up for the Viking Energy of Northumberland Limited Partnership's consumptive use. Red Run is a tributary to Lycoming Creek, which flows into the West Branch Susquehanna River. The West Branch Susquehanna River meets the main stem of the Susquehanna River at the outlet of Section 5 of the Upper Susquehanna Subbasin.

TABLE 50

MINERAL INDUSTRIAL WITHDRAWALS IN SECTION 5
TOTAL USE

Withdrawal	Source	Base (gpd)	1990 (gpd)	2000 (gpd)	2010 (gpd)
Amscot Coal(1)	SW	269,000	269,000	269,000	269,000
Amscot Coal(2)	GW	115,000	115,000	115,000	115,000
Bear Gap Quarry & Mill(1)	SW	1,560	1,560	1,560	1,560
Bear Gap Quarry & Mill(2)	GW	22	22	22	22
Beaver Brook Coal	GW	37,500	37,500	37,500	37,500
Bloomsburg Sand & Gravel	SW	144,000	144,000	144,000	144,000
Central Builders(1)	SW	16,000	16,000	16,000	16,000
Central Builders(2)	GW	68,400	68,400	68,400	68,400
Central Builders(3)	GW	197	197	197	197
Columbia Asphalt Corp.	SW	22,900	22,900	22,900	22,900
Gowen Coal Co.(1)	SW	40	40	40	40
Gowen Coal Co.(2)	GW	62,100	62,100	62,100	62,100
J.A.W.A. Hess	SW	10,000	10,000	10,000	10,000
Jeddo No. 7 Breaker	GW	2,150,000	2,150,000	2,150,000	2,150,000
Kelly Investors	GW	625	625	625	625
Northumberland Plant(1)	SW	2	2	2	2
Northumberland Plant(2)	GW	60	60	60	60
Northumberland Plant(3)	GW	16,100	16,100	16,100	16,100
Penn Peat Moss	GW	110	110	110	110
Shirley M. Rinehimer	SW	300,000	300,000	300,000	300,000
TOTALS		3,213,616	3,213,616	3,213,616	3,213,616

TABLE 51

MINERAL INDUSTRIAL WITHDRAWALS IN SECTION 5
CONSUMPTIVE USE

Withdrawal	SIC	Base (gpd)	1990 (gpd)	2000 (gpd)	2010 (gpd)
Amscot Coal(1)	1,111	21,493	21,493	21,493	21,493
Amscot Coal(2)	1,111	9,189	9,189	9,189	9,189
Bear Gap Quarry & Mill(1)	1,429	105	105	105	105
Bear Gap Quarry & Mill(2)	1,429	1	1	1	1
Beaver Brook Coal	1,111	2,996	2,996	2,996	2,996
Bloomsburg Sand & Gravel	1,442	7,517	7,517	7,517	7,517
Central Builders(1)	1,442	835	835	835	835
Central Builders(2)	1,442	3,570	3,570	3,570	3,570
Central Builders(3)	1,442	10	10	10	10
Columbia Asphalt Corp.	1,429	1,534	1,534	1,534	1,534
Gowen Coal Co.(1)	1,111	3	3	3	3
Gowen Coal Co.(2)	1,111	4,962	4,962	4,962	4,962
J.A.W.A. Hess	1,442	522	522	522	522
Jeddo No. 7 Breaker	1,111	171,785	171,785	171,785	171,785
Kelly Investors	1,111	50	50	50	50
Northumberland Plant(1)	1,442	0	0	0	0
Northumberland Plant(2)	1,442	3	3	3	3
Northumberland Plant(3)	1,442	840	840	840	840
Penn Peat Moss	1,211	20	20	20	20
Shirley M. Rinehimer	1,442	15,660	15,660	15,660	15,660
TOTALS		241,095	241,095	241,095	241,095

TABLE 52

GOLF COURSE WATER USE IN SECTION 5

Withdrawal	Source	Total Use (gpd)	Consumptive Use (gpd)
Mill Race Golf Course	SW	151,000	128,350
Edgewood Golf Course	SW	285,000	242,250
Sugarloaf Golf Course	SW	213,000	181,050
Berwick Golf Course	SW	165,000	140,250
Valley Country Club	GW	129,000	109,650
Valley Country Club	SW	32,200	27,370
Wolf Hollow Golf Course	SW	20,400	17,340
Willow Run Inn	SW	67,200	57,120
Cherokee Golf Course	SW	81,500	69,275
Tree Ponds Golf Course	SW	184,000	156,400
Tree Ponds Golf Course	SW	46,100	39,185
Frosty Valley Country Club	SW	36,000	30,600
TOTALS		1,410,400	1,198,840

TABLE 53
TOTAL WATER USE SUMMARY FOR SECTION 5*

User	Total Use (MGD) Base	1990	2000	2010
Municipal				
Domestic & Industry	21.84	21.22	19.77	18.92
Industrial				
Non-Mineral Self-Supplied	8.75	9.21	11.73	11.76
Mineral Self-Supplied	3.21	3.21	3.21	3.21
Agriculture				
Livestock	0.54	0.54	0.54	0.54
Irrigation	2.89	2.89	2.89	2.89
TOTAL	37.23 (57.61 cfs)	37.07 (57.36 cfs)	38.14 (59.02 cfs)	37.32 (57.75 cfs)

* Assuming potential low flow conditions.

TABLE 54
CONSUMPTIVE WATER USE SUMMARY FOR SECTION 5*

User	Consumptive Use (MGD) Base	1990	2000	2010
Municipal				
Domestic & Industry	4.37	5.09	4.80	4.63
Industrial				
Non-Mineral Self-Supplied	0.67	0.96	3.46	3.46
Mineral Self-Supplied	0.24	0.24	0.24	0.24
Agriculture				
Livestock	0.40	0.40	0.40	0.40
Irrigation	2.45	2.45	2.45	2.45
TOTAL CONSUMPTIVE USE	8.13 (12.58 cfs)	9.14 (14.14 cfs)	11.35 (17.56 cfs)	11.18 (17.29 cfs)
ADJUSTED CONSUMPTIVE USE**	8.13 (12.58 cfs)	8.85 (13.69 cfs)	11.06 (17.11 cfs)	10.90 (16.87 cfs)

* Assuming potential low flow conditions.
** Total consumptive use minus consumptive use by Viking Energy. This value is used in storage calculations (Chapter IX) since water from Red Run Reservoir will be released as make-up for Viking Energy's consumptive use.

TABLE 55

FLOWS AT OR BELOW THE 7-DAY 10-YEAR LOW FLOW VALUE
FOR SUSQUEHANNA RIVER AT DANVILLE, PA. DURING PERIOD 1905-1987
(USGS SITE NO. 01540500)

Calendar Year	No. of Days Occurred	Months Occurred/ No. Days Per Month
1908	24	Sep./22, Oct./2
1913	13	Sep./13
1930	8	Oct./8
1932	8	Sep./7, Oct./1
1939	23	Aug./2, Sep./21
1941	3	Sep./1, Oct./2
1953	2	Sep./2
1955	12	Jul./1, Aug./11
1959	5	Sep./5
1962	5	Aug./5
1963	27	Sep./1, Oct./20, Nov./6
1964	91	Aug./10, Sep./26, Oct./30, Nov./25
1965	3	Jul./3
TOTAL	224	Jul./4, Aug./28, Sep./98, Oct./63 Nov./31

FIGURE 13

NUMBER OF DAYS 7-DAY 10-YEAR LOW FLOW OCCURRED
DURING PERIOD 1905 – 1987
SUSQUEHANNA RIVER AT DANVILLE, PA.

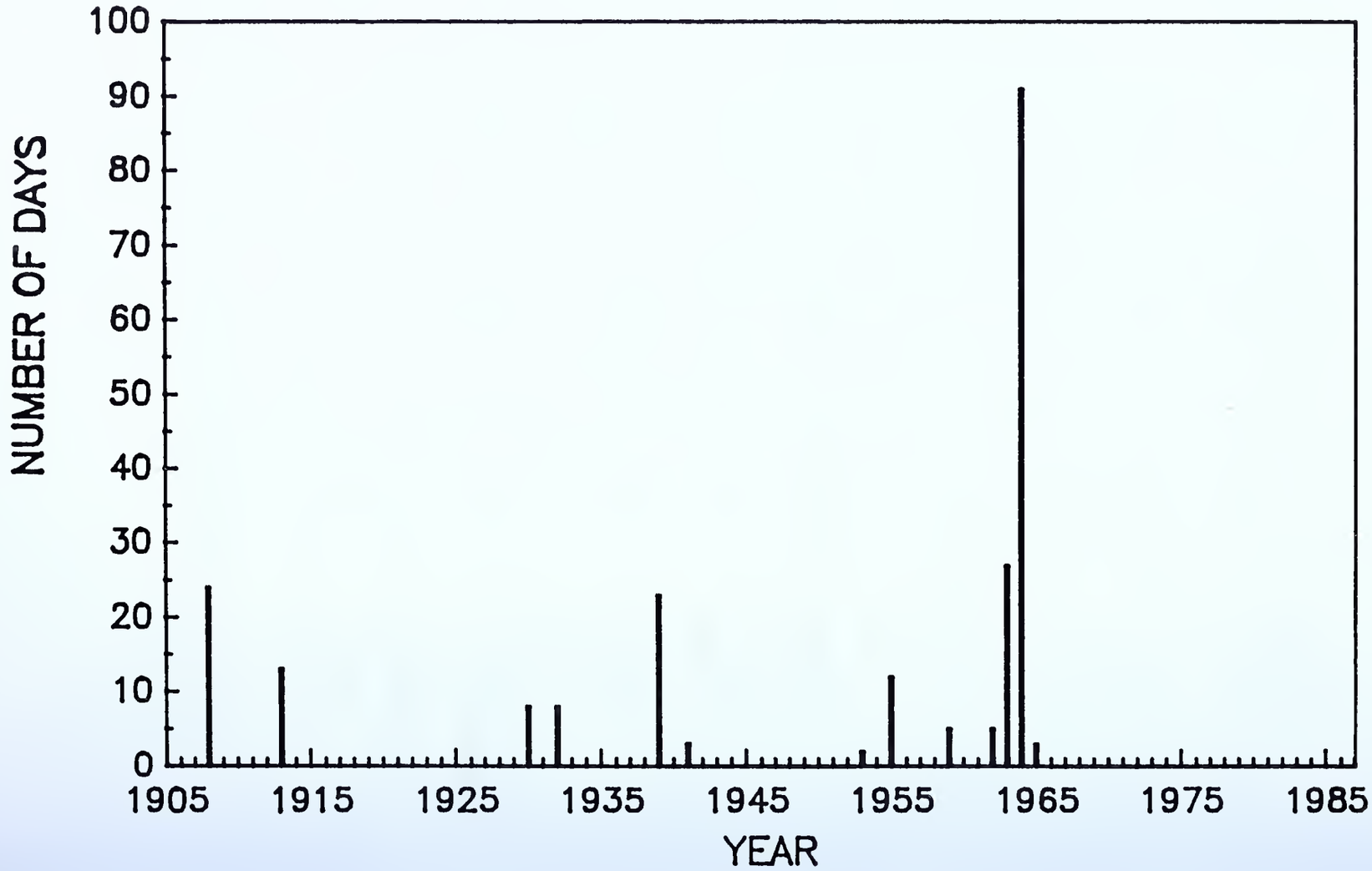
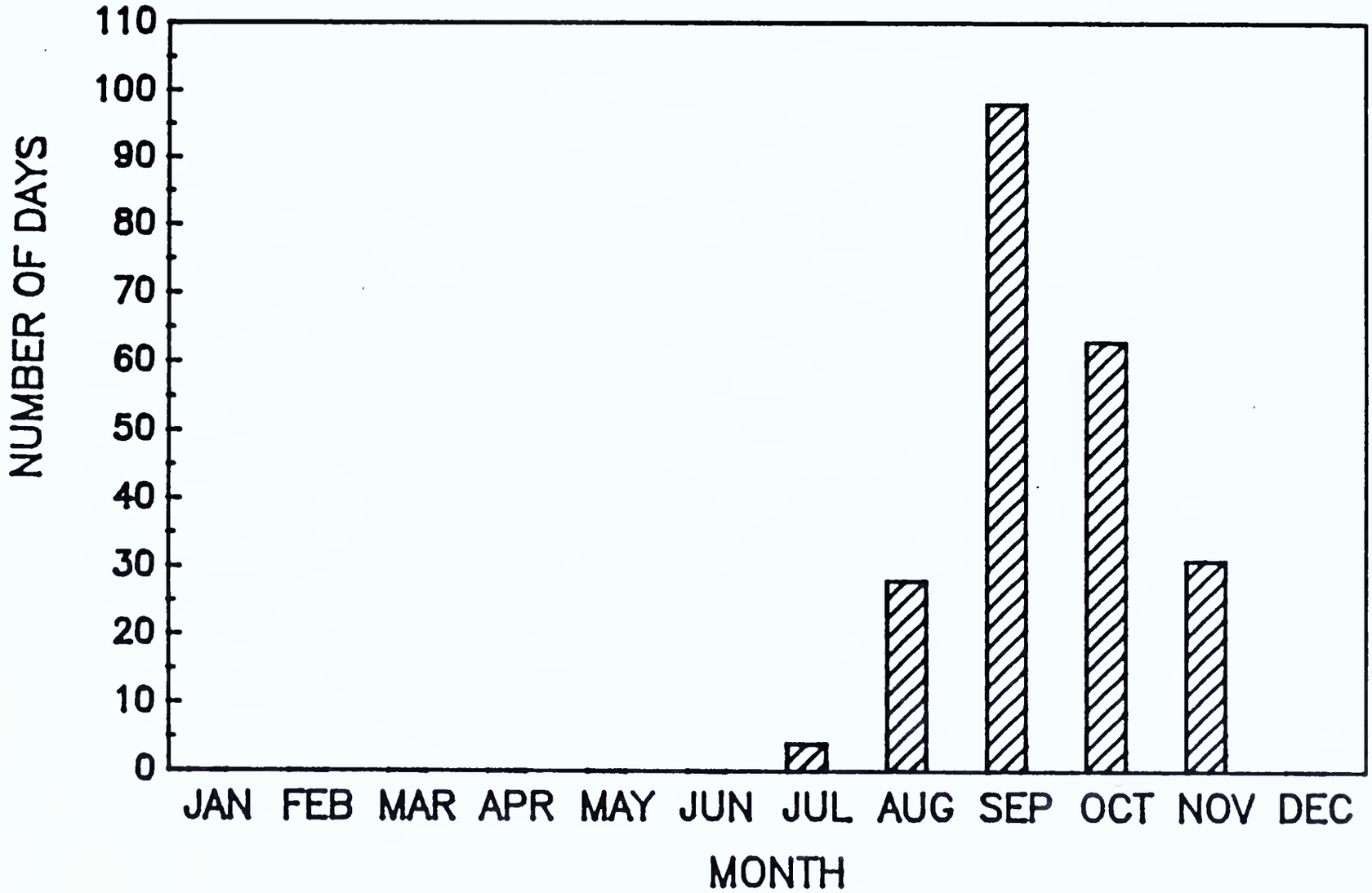


FIGURE 14

NUMBER OF DAYS 7–DAY 10–YEAR LOW FLOW OCCURRED IN EACH MONTH SUSQUEHANNA RIVER AT DANVILLE, PA. (FOR PERIOD 1905 – 1987)



Danville, Pa. Flows at or below the Q7-10 value have been reported in July, August, September, October and November of various years. Flows of this magnitude occurred during more days in 1964 than in any other year of record.

IX. PRESENT AND FUTURE LOW FLOW PROBLEMS AND NEEDS

A. GENERAL

A primary goal of this framework plan is to facilitate management of stream flows during periods of low water availability. Adequate stream flows provide pollution assimilation capability, support aquatic life, provide recreational opportunities, and provide water for municipal and industrial uses. From a basinwide perspective, the SRBC places high priority on the maintenance of flows for protection of the Chesapeake Bay.

Instream flow needs are not precisely known. However, regulatory agencies have focused on the Q7-10 value as a minimum flow used in establishing state water quality standards and National Pollutant Discharge Elimination System (NPDES) permit limitations, and in designing municipal sewage treatment plants. The SRBC's consumptive use make-up regulation (18 CFR Section 803.61) focuses upon preventing new consumptive water uses from further reducing stream flows when natural flows are less than or equal to the Q7-10 value.

Stream flows less than the Q7-10 value may not create undesirable conditions in all streams under all circumstances. The SRBC framework plans use the Q7-10 value as a target to allow comparison of potential water deficits during low flow events. The Q7-10 value is used for comparison purposes only

and is not considered to be the minimum acceptable flow which must be maintained.

A water shortage may be caused by man's actions under two general types of conditions. First, a shortage may occur at any given point if stream flow is less than a specific withdrawal plus the quantity of instream flow desired downstream of the withdrawal. For example, a stream flow of 50 cfs at a given location would generally be insufficient to provide water for instream needs of 48 cfs plus a municipal withdrawal of 5 cfs at the same location.

A man-induced water shortage could occur when aggregated upstream consumptive uses plus the desired minimum flow exceed the available stream flow. In many instances, much of the water withdrawn from the stream is ultimately returned, primarily by way of industrial and municipal treatment plant outfalls. However, many uses consume a portion of the water withdrawn. Consumption permanently removes water from the stream system, thereby affecting the entire length of stream below the point of withdrawal. As an example, assume that the minimum flow requirement at the mouth of a stream is 18 cfs. During a particular event with a given set of climatological conditions, flows in the stream fell to 18.5 cfs at the mouth. This particular low flow event occurred under "natural" conditions during a historical period when the watershed was undeveloped and consumptive use by man was essentially zero. The watershed was

subsequently developed and the cumulative water consumption from all surface withdrawals increased to 2 cfs. If the meteorological conditions causing the previous low flow event were repeated, flows at the stream mouth would be 16.5 cfs (18.5 cfs natural flow minus 2 cfs consumptive use). Since the desired minimum flow is 18 cfs, a man-induced water shortage attributable to consumptive use would occur.

In planning for periods of low water availability, it should be noted that the presence of water does not guarantee that it can be used for all desired purposes. Pollution can render water supplies unfit for some uses, or require that costly treatment processes be implemented.

B. AGGREGATED CONSUMPTIVE USE AND MAINTENANCE OF THE Q7-10 VALUE

Table 56 provides estimates of the aggregated upstream consumptive uses having the potential to affect stream flows at the outlet of each section of the Upper Susquehanna Subbasin. At the outlets of Sections 3, 4, and 5, total adjusted upstream consumptive uses (excluding projects providing make-up) are expected to be less in 1990, 2000, and 2010 than they were in the base year. Table 57 summarizes storage requirements that would be needed to maintain the Q7-10 value at the outlet of each subbasin section, considering the aggregate upstream consumptive use.

TABLE 56

TOTAL ADJUSTED CONSUMPTIVE USE UPSTREAM OF THE OUTLET OF EACH SECTION OF THE UPPER SUSQUEHANNA SUBBASIN*

Section Outlet & Location	Upstream Consumption (cfs)			
	Base	1990	2000	2010
1 Susquehanna River above Mouth of Meshoppen Creek	61.75	62.88	66.74	67.36
2 Susquehanna River above Mouth of Lackawanna River	67.82	69.13	73.31	74.24
3 Mouth of Lackawanna River	12.43	11.56	10.82	10.21
4 Susquehanna River below Mouth of Wapwallopen Creek	145.84	95.33	97.73	97.44
5 Susquehanna River above Mouth of West Branch Susquehanna River	158.42	109.03	114.84	114.30

* Less consumptive use by projects providing water as make-up for their consumptive use. Estimates apply to low flow conditions. Includes upstream consumptive uses from the Chemung and Eastern Subbasins.

TABLE 57

STORAGE REQUIREMENTS TO MAINTAIN THE 7-DAY 10-YEAR LOW FLOW VALUE AT THE OUTLET OF EACH SECTION OF THE UPPER SUSQUEHANNA SUBBASIN

Section Outlet	Most Critical Period (Climatic Yr.)	Gage(s) Used For Analysis	Section Q7-10 (cfs)	Storage Needed (Acre-Feet) Base	1990	2000	2010
1	1964	01531500 01532000 01534000	600.5	35910	36143	36940	37068
2	1964	01531500 01532000 01534000	639.2	39660	39930	40793	40984
3	1964	01536000*	40.9	2745	2604	2483	2384
4	1964	01536500	844.0	54869	45251	45708	45653
5	1964	01540500	1003.7	63797	54882	55931	55833

* Much water from the Lackawanna River is diverted through underground mines to points downstream of this gage. When calculating storage for Section 3, data from this gage were not adjusted to account for this diversion.

Note: The Q7-10 values cited above are calculated values that were used to assess storage requirements discussed in this report. These values are tabulated to the nearest 0.1 cfs in order to make comparisons of storage needs uniform regardless of watershed size.

C. OTHER CONSIDERATIONS

1. SRBC Consumptive Use Make-Up Regulation

Enforcement of the SRBC consumptive use make-up regulation (18 CFR Section 803.61) will help reduce the effects on stream flow caused by large, new consumptive users. However, consumptive uses existing prior to January 23, 1971, as well as those consuming less than 20,000 gpd, are exempt from make-up requirements. The regulation does not mandate that stream flows be maintained at any given level. It only requires that during low flow periods, individual consumptive users must provide make-up water in the amount that they consume.

2. Data Needs

General. Complications often arose in the development of water use estimates due to either a lack of information or the incompatibility of data from various sources. Numerous assumptions had to be made to allow the development of data presented in this report.

Agricultural water use was especially difficult to quantify. Irrigation and livestock use were calculated as worst case estimates that, due to a lack of data, were assumed constant through the year 2010. Although increases in agricultural water use will probably occur, data were not available to estimate the magnitude of the increases.

Irrigation water use data developed by Cornell University (Steenhuis and others, 1986) were used to prepare irrigation consumptive use estimates for both the Chemung Subbasin Low Flow Management Framework Plan (Heicher and others, 1987) and the Eastern Subbasin Low Flow Management Framework Plan (Heicher and Hirschel, 1988). However, similar data are not available for the Upper Susquehanna Subbasin or any of the other subbasins in Pennsylvania. Based on the estimates prepared for the Chemung and Eastern Subbasin Low Flow Management Framework Plans. Commission staff believe that the development of data using the Cornell methodology would probably produce somewhat greater irrigation estimates than those cited in this report.

No system for monitoring irrigation during actual low flow periods presently exists. Although agricultural censuses have been performed once every four or five years, census years do not necessarily coincide with dry years having heavy irrigation and low stream flows. A system for monitoring irrigation would provide valuable information for water use planning and would facilitate enforcement of the SRBC consumptive use make-up regulation with respect to irrigation projects.

Desired Flows to the Chesapeake Bay. The Chesapeake Bay Study (U.S. Army Corps of Engineers, 1984b) states that decreases in the amount of fresh water to the Bay have had serious environmental, social, and economic impacts in the past and are

expected to have more significant impacts in the future. The problem is aggravated during low flow periods.

The Chesapeake Bay and Tributaries Reallocation Study Reconnaissance Report (U.S. Army Corps of Engineers, 1988) states that during droughts, the amount of Bay habitat available for species requiring low salinities is reduced, and diseases associated with high salinity move up the Bay. In addition, the report states that the rate and timing of freshwater inflows to the Bay can have a great influence on the reproductive success of anadromous fish, oysters, and other important species.

Section III.A.16. (Guidelines and Criteria) of the Commission's Comprehensive Plan states that "Low flows to the Chesapeake Bay shall not be reduced. Low flow to the Chesapeake Bay is defined as the one-in-twenty year average monthly low flow in each of the months of August, September, and October." The SRBC is currently working with the State of Maryland to determine freshwater flow requirements to the Bay. Until this information is available, it is impossible to determine the degree to which maintenance of the Q7-10 value at the mouth of the Upper Susquehanna Subbasin would contribute to the achievement of target freshwater flow requirements to the Chesapeake Bay.

X. ALTERNATIVE MANAGEMENT ACTIONS

A. GENERAL

Two categories of management actions were considered with respect to maintenance of minimum stream flows.

- Implement water conservation measures, and
- Provide water from surface water reservoirs.

In considering the above actions, it should be noted that over the long term, flow management could increase stream levels during low flows and could therefore increase the Q7-10 values at some sites over a period of years. Unless appropriate adjustments are made to the observed record, increasing Q7-10 values resulting from flow management will increase the calculated storage amounts cited in Chapter IX.

B. WATER CONSERVATION

Consultation with Pa. DER staff indicates that in an emergency situation, municipal systems implementing conservation measures are commonly able to achieve a 25 percent reduction in water demand. Water conservation may be an excellent way to avoid the depletion of municipal and industrial water supplies, but could provide only limited benefits to stream flows in the Upper Susquehanna Subbasin. Conservation increases stream flows only to the extent that it reduces consumptive use or out-of-basin diversions. The effect of conservation on consumptive use is unknown.

Total baseline consumptive use above the outlet of the subbasin (adjusted for projects providing make-up water) is estimated to be 102.38 MGD (158.42 cfs), while the Q7-10 value for the Danville gage on the Susquehanna River is 996.4 cfs. During the most critical year of record for this gage, flows were at or below the Q7-10 value for 91 days. If natural flows were increased by 39.61 cfs (25 percent of 158.42 cfs), flows would still be at or below the Q7-10 value for 81 days. Conservation therefore could not provide enough water to maintain flows at the Q7-10 value during a repeat of the most critical year of record.

C. SURFACE WATER RESERVOIRS

1. Reallocation of Storage at Existing Federal Reservoirs

The Baltimore District, U.S. Army Corps of Engineers, has prepared an October, 1988 Reconnaissance Report for its Chesapeake Bay and Tributaries Reallocation Study. The purpose of the reallocation study was to examine a wide range of water resource problems, with particular emphasis on evaluating the feasibility of reallocating storage at existing Federal reservoirs.

The Baltimore District is presently conducting feasibility studies concerning the reallocation of storage at two reservoirs located outside the Upper Susquehanna Subbasin. Reallocation of storage at Raystown Lake in the Juniata Subbasin is being considered as a means to satisfy instream fishery and water supply needs in the lower Susquehanna River and to increase flows

to the Chesapeake Bay during low flow periods. Reallocation of storage at Curwensville Reservoir in the West Branch Susquehanna River Subbasin is being considered as a means of providing consumptive use make-up water for a number of consumptive users throughout the Susquehanna River Basin. Neither of these projects could result in increased stream flows in the Upper Susquehanna Subbasin, since they are located downstream.

Several consumptive users in the vicinity of Binghamton, N.Y. have requested that the Corps consider the possibility of reallocating storage in East Sidney and Whitney Point Reservoirs, located in the Eastern New York Subbasin. The Corps has decided to focus on the reallocation of storage at East Sidney Reservoir, because it appears to be the more appropriate site. The Corps is presently seeking funding from internal sources for a feasibility study.

In addition to East Sidney and Whitney Point Reservoirs, the Corps owns and operates Almond, Tioga-Hammond, and Cowanesque Reservoirs, which are also located upstream of the Upper Susquehanna Subbasin. Storage was recently reallocated at Cowanesque Reservoir to provide consumptive use make-up water for the Susquehanna Steam Electric Station at Berwick, Pa. and the Three Mile Island power plant near Middletown, Pa. As stated previously, Stillwater Reservoir and Aylesworth Creek Lake are located in the Upper Susquehanna Subbasin.

Any proposed change in the allocation of storage at an existing Corps reservoir would have to be evaluated for potential environmental impacts. The effect on the project's authorized purposes would also need to be evaluated, since a change in the project's authorized purposes would affect attendant cost allocation.

2. New Reservoir Sites

Potential reservoir sites in the Upper Susquehanna Subbasin were identified by the Susquehanna River Basin Study Coordinating Committee (1970), the U.S. Army Corps of Engineers (1986), and the U.S. Department of Agriculture (1977). Information regarding these sites is summmarized in Appendix B. Potential site locations and reservoir storage capacities described by the above are listed in Table 58.

Although Table 58 identifies vast quantities of storage associated with reservoir sites that were considered in the past, the present economic, environmental, and social costs of developing one or more of these sites for low flow management purposes are unknown. None of these sites are presently proposed as storage reservoirs for low flow management. Additional detailed investigations would be required to determine the engineering, economic, environmental, and political feasibility of reservoir construction for low flow management at any site.

TABLE 58

LOCATIONS & STORAGE CAPACITIES OF RESERVOIR SITES PREVIOUSLY IDENTIFIED IN THE UPPER SUSQUEHANNA SUBBASIN

Location	Storage Capacity (Acre Ft.)
SECTION 1 - Susquehanna River From Mouth of Chemung River to Meshoppen Creek	
Sugar Creek 1	7,450
Parks Creek	1,190
Pettis Creek	2,250
N. Br. Wyalusing Creek	4,625
Tributary to S. Br. Towanda Creek 1	1,220
Tributary to Tuscarora Creek	910
Rummerfield Creek	735
Towanda	89,057
Tributary to S. Br. Towanda Creek 2	1,220
Tributary to S. Br. Towanda Creek 3	1,480
S. Br. Towanda Creek	6,150
Tributary to S. Br. Towanda Creek 4	800
N. Br. Towanda Creek	3,030
Sugar Creek 2	3,700
Brace Creek 1	2,410
Peas Creek	7,220
W. Br. Tomjack Creek	6,900
Mud Creek	2,660
Sugar Creek 3	1,380
Tributary to N. Br. Sugar Creek	6,260
Brace Creek 2	1,650
Leonard Creek	1,350
Tributary to Wyalusing Creek	3,200
Middle Branch Creek	4,700
Gaylord Creek	3,300
Deer Lick Creek	2,050
Tributary to Sugar Run	3,329
Little Tuscarora Creek	884
Mill Creek	2,748
Vought Creek	1,159
Johnson Creek	3,232
Bullard Creek	1,122
Wilson Creek	1,778
SECTION 1 TOTAL	181,149

TABLE 58
(Cont'd)

LOCATIONS & STORAGE CAPACITIES OF RESERVOIR SITES PREVIOUSLY IDENTIFIED IN THE UPPER SUSQUEHANNA SUBBASIN

Location	Storage Capacity (Acre Ft.)
SECTION 2 - Meshoppen Creek & Susquehanna River From Meshoppen Creek to Lackawanna River	
E. Br. Tunkhannock Creek 1	1,280
Buttermilk Creek	1,680
Beaver Run	4,325
Tunkhannock	59,000
Tunkhannock Creek	14,980
E. Br. Tunkhannock Creek 2	1,809
E. Br. Tunkhannock Creek 3	3,901
Idlewood Creek	5,410
Horton Creek	1,456
Kern Glen Creek	1,179
Billings Mill Brook	624
Martins Creek	132
Tributary to Hopbottom Creek	49
Thomas Creek	4,190
Meshoppen Creek	4,964
Tributary to Nick Creek	1,456
Tributary to Gardner Creek	1,040
Gardner Creek	2,903
Buttermilk Creek 1	616
Buttermilk Creek 2	763
Tributary to Meshoppen Creek	684
SECTION 2 TOTAL	112,441
SECTION 3 - Lackawanna River	
E. Br. Lackawanna River	4,640
E. Br. Roaring Brook	4,300
Tributary to Lackawanna River	1,370
Lackawanna River	5,100
SECTION 3 TOTAL	15,410
SECTION 4 - Susquehanna River from Mouth to Lackawanna River to & Including Wapwallopen Creek	
Wapwallopen Creek 1	3,510
Harvey Creek	7,410

TABLE 58
(Cont'd)

LOCATIONS & STORAGE CAPACITIES OF RESERVOIR SITES PREVIOUSLY IDENTIFIED IN THE UPPER SUSQUEHANNA SUBBASIN

Location	Storage Capacity (Acre Ft.)
Little Shickshinny Creek 1	3,610
Andy's Pond	?
Wapwallopen	39,000
Wapwallopen Creek 2	2,183
Tributary to Wapwallopen Creek	6,745
Little Wapwallopen Creek 1	1,239
Little Wapwallopen Creek 2	5,078
Tributary to Pond Creek	1,015
Abraham Creek	1,246
Tributary to Spring Run	2,735
Tributary to Harvey Creek	1,542
Roaring Brook	1,052
Tributary to Shickshinny Creek	1,823
Little Shickshinny Creek 2	2,236
SECTION 4 TOTAL	80,424
SECTION 5 -	
Berwick	?
Beaver Run	1,350
Green Creek	22,400
Briar Creek	375
Jonestown	62,300
Huntington Creek 1	5,030
Marsh Creek	1,706
Tributary to Huntington Creek	1,190
Huntington Creek 2	16,300
Pine Creek 1	13,790
Pine Creek 2	2,990
Maple Run Creek	2,560
Little Fishing Creek	7,000
Tributary to Nescopeck Creek	770
Nescopeck Creek 1	5,280
Little Nescopeck Creek	1,190
Tenmile Run	3,236
W. Br. Briar Creek	1,700
E. Br. Briar Creek	1,010
Glen Brook	292
Nescopeck Creek 2	19,593
Tributary to Catawissa Creek	2,900
Scotch Run	4,920

TABLE 58
(Cont'd)

LOCATIONS & STORAGE CAPACITIES OF RESERVOIR SITES PREVIOUSLY IDENTIFIED IN THE UPPER SUSQUEHANNA SUBBASIN

Location	Storage Capacity (Acre Ft.)
Tomhicken Creek	5,785
Tributary to Little Catawissa Creek	4,600
Tributary to Roaring Creek	3,324
Lick Run	1,615
Mugser Run	3,461
Tributary to Susquehanna River	3,237
SECTION 5 TOTAL	199,904

XI. CONCLUSIONS

This report uses the Q7-10 value as an indicator to identify historical low flow periods, and to determine potential water deficits within watersheds of the Upper Susquehanna Subbasin during a repeat of the most severe historical low flow period. In general, baseline (1980) upstream consumptive loss ranged from about 10 percent to 30 percent of the Q7-10 value at the outlets of major stream sections in the subbasin.

Total consumptive use in the Upper Susquehanna Subbasin under baseline low flow conditions is about 65 MGD. Consumptive use in the subbasin is projected to increase to 66 MGD in 2000, and to remain at approximately that level through 2010.

Total baseline consumptive use upstream of the outlet of the Upper Susquehanna Subbasin (including consumptive uses in the Chemung and Eastern Subbasins) is about 102 MGD. Upstream consumptive uses in 1990, 2000, and 2010 are projected to be 104 MGD, 107 MGD, and 107 MGD, respectively.

Several projects in the Upper Susquehanna Subbasin presently have sources of make-up water that have been approved by the Commission for the release of water as compensation for their consumptive use during low flow periods. Although the consumptive uses associated with these projects will continue to

occur, their effects on stream flow will be reduced during periods when make-up water is being provided for these projects in accordance with the SRBC consumptive use make-up regulation (Commission Regulation 803.61). If the estimated consumptive use upstream of the outlet of the subbasin is adjusted by subtracting the consumptive use of projects providing make-up, the adjusted consumptive uses for 1990, 2000, and 2010 are 70 MGD, 74 MGD, and 74 MGD, respectively. The adjusted consumptive use estimates will be reduced further if additional projects find acceptable sources of consumptive use make-up water in accordance with Commission Regulation 803.61.

The adjusted consumptive use values were used to estimate that, if meteorological conditions producing the 1964 drought had been repeated under baseline conditions, about 63,797 acre feet of water would have been required to maintain Q7-10 flows at the mouth of the Upper Susquehanna Subbasin. An estimated 55,833 acre feet of water would be required if the 1964 drought were repeated in the year 2010. The amount of water storage needed to maintain flows at the Q7-10 value at the outlet of each stream section is also provided in this report.

A more thorough knowledge of minimum instream flow requirements and the fresh water inflow requirements of the Chesapeake Bay are required to establish definitive low flow goals for key locations in the Upper Susquehanna Subbasin.

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APPENDIX A

SUPPORTING DATA FOR INDUSTRIAL WATER USE CALCULATIONS

DEPARTMENT OF ENVIRONMENTAL RESOURCES

Consumptive Water Use for 2-digit SIC Groups in per cent of Total Water Withdrawal

FILE NO

SECTION NO

SHEET NO

COMPUTED BY

CHECKED BY

DATE 7/2/71

MADE IN CONNECTION WITH

SIC	Consumptive Use (%)	Comments
All	7.70	*
20	07.15	*
21	16.7	*
22	11.7	*
23	7.70	**
24	7.70	**
25	0.00	*
26	7.73	*
27	7.70	**
28	6.72	*
29	15.2	*
30	5.19	*
31	6.25	*
32	13.1	*
33	6.17	*
34	4.41	*
35	4.23	*
36	7.09	*
37	6.39	*
38	5.26	*
39	7.14	*

* Computed from Table 1A, page 7-16, from "1967 Census of Manufactures - Water Use in Manufacturing." MC67(1)-7 U.S. Department of Commerce

** No values were determined by the reference. Therefore the national average for all manufacturers was substituted.

15 Gallons per employee
30 Gallon " " with sha

DEPARTMENT OF ENVIRONMENTAL RESOURCES

FWFC-D-10

SUBJECT Consumptive Water Use — Mineral Industies [derived from Table 6, page 17; of "Water Use In The Mineral Industry"; Bureau of Mines Information Circular #8285]

FILE NO.

SECTION NO.

SHEET NO.

COMPUTED BY T.S.S. CHECKED BY DATE 7/18/7

MADE IN CONNECTION WITH

SIC		% Consumption of Withdrawal
1011	Iron Ore	6.13
1021	Copper Ore	37.43
1031	Lead and Zinc Ore	6.71
104	Gold and Silver Ore	1.18
1094	Uranium-Radium-Vanadium	42.00
111	Anthracite Coal	7.99
121	Bituminous Coal	17.85
131	Petroleum and Nat. Gas	90.98
132	Natural Gas Liquids	32.92
141	Dimension Stone	3.99
142	Crushed and Broken Stone	6.70
144	Sand and Gravel	5.22
145	Clay	11.74
1472	Barite	8.53
1474	Potash, Soda, Borate	39.47
1475	Phosphate Rock	25.59
1476	Rock Salt	23.92
1477	Sulfur	26.40
	Other	8.85
	Total	24.90

RATIO OF THE PROJECTED VALUE ADDED TO THE BASE YEAR 1980
FOR EACH GROWING TWO-DIGIT SIC GROUP IN PENNSYLVANIA

SIC CODE	INDUSTRY	PROJECTED VALUE ADDED RATIO		
		1990	2000	2010
20	Food & Kindred Products	1.14	1.26	1.38
25	Furniture & Fixtures	1.31	1.41	1.51
26	Paper & Allied Products	1.12	1.32	1.52
27	Printing & Publishing	1.19	1.37	1.55
38	Instruments; Photographic, Medical, & Optical Goods; Watches & Clocks	1.25	1.53	1.81

APPENDIX B

POTENTIAL RESERVOIR SITES IN THE UPPER SUSQUEHANNA SUBBASIN

APPENDIX B

POTENTIAL RESERVOIR SITES
UPPER SUSQUEHANNA RIVER SUBBASIN

A. Susquehanna River Basin Coordinating Committee, 1970, Susquehanna River Basin Study, Appendix K(2), Structural Measures.

SECTION 1

1. Sugar Creek

   Type: Recreation and Fish Habitat
   Location: 1.5 miles northwest of Troy, PA.
   Drainage Area: 13.1 sq. miles
   Storage: 7450 acre-feet
   Surface Area: 340 acres
   Note: Recommended for potential development by 1980

2. Parks Creek

   Type: Recreation and Fish Habitat
   Location: 2 miles north of Rome, PA.
   Drainage Area: 4.6 sq. miles
   Storage: 1190 ac-ft
   Surface Area: 107 acres
   Note: Recommended for Potential development by 1980

3. Pettis Creek

   Type: Recreation and Fish Habitat
   Location: 1.5 miles southwest of Montrose, PA.
   Drainage Area: 5.1 sq. miles
   Storage: 2250 ac-ft
   Surface Area: 71 acres
   Note: Recommended for potential development by 2000

4. North Branch Wyalusing Creek

   Type: Recreation and Fish Habitat
   Location: 1 mile south of Middletown Center, PA.
   Drainage Area: 14 sq. miles
   Storage: 4625 ac-ft
   Surface Area: 218 acres
   Note: Recommended for potential development by 2000

5. Tributary South Branch Towanda Creek

Type: Recreation and Fish Habitat
Location: 2 miles southeast of Monroeton, PA.
Drainage Area: 2.3 sq. miles
Storage: 1220 ac-ft
Surface Area: 95 acres
Note: Recommended for potential development by 2000

6. Tributary Tuscarora Creek

Type: Recreation and Fish Habitat
Location: 6.5 miles northwest of Skinners Eddy, PA.
Drainage Area: 1.7 sq. miles
Storage: 910 ac-ft
Surface Area: 40 acres
Note: Recommended for potential development by 2020

7. Rummerfield Creek

Type: Recreation and Fish Habitat
Location: 6.5 miles east of Wysox, Pa.
Drainage Area: 2.3 sq. miles
Storage: 735 ac-ft
Surface Area: 54 acres
Note: Recommended for Potential development by 2020

SECTION 2

1. East Branch Tunkhannock Creek

Type: Fishing
Location: 4 miles east of South Gibson, PA.
Drainage Area: 2.4 sq. miles
Storage: 1280 ac-ft
Surface Area: 75 acres
Note: Recommended for potential development by 1980

2. Buttermilk Creek

Type: Recreation and Fish Habitat
Location: 3 miles south of Lake Winola, PA.
Drainage Area: 20.2 sq. miles
Storage: 1860 ac-ft
Surface Area: 140 acres
Note: Recommended for potential development by 1980

3. Beaver Run

Type: Recreation and Fish Habitat
Location: 1.5 miles southwest of Noxon, PA.
Drainage Area: 8.1 sq. miles
Storage: 4325 ac-ft
Surface Area: 260 acres
Note: Recommended for potential development by 2000

4. Tunkhannock

Type: Recreation and Fish Habitat
Location: 3.5 miles above the creek mouth
Drainage Area: 385 sq. miles
Storage: 59,000 ac-ft
Surface Area: No Data
Note: Recommended for potential development by 2020

SECTION 3

1. East Branch Lackawanna River

Type: Recreation and Fish Habitat
Location: 9 miles north of Forest City, PA.
Drainage Area: 13 sq. miles
Storage: 4640 ac-ft
Surface Area: 298 acres
Note: Recommended for potential development by 1980

SECTION 4

1. Wapwallopen Creek

Type: Recreation and Fish Habitat
Location: 1 mile west of Mountain Top, PA.
Drainage Area: 6.5 sq. miles
Storage: 3510 ac-ft
Surface Area: 277 acres
Note: Recommended for potential development by 1980

2. Harvey Creek

Type: Recreation and Fish Habitat
Location: 5 miles northwest of Plymouth, PA.
Drainage Area: 19.9 sq. miles
Storage: 7410 ac-ft
Surface Area: 391 acres
Note: Recommended for potential development by 1980

3. Little Shickshinny Creek

Type: Recreation and Fish Habitat
Location: 3.5 miles west of Shickshinny, PA.
Drainage Area: 6.7 sq. miles
Storage: 3610 ac-ft
Surface Area: 302 acres
Note: Recommended for potential development by 1980

4. Andy's Pond

Type: Recreation and Fish Habitat
Location: 3 miles northeast of Dorrance, PA.
Drainage Area: 7.4 sq. miles
Storage: No Data
Surface Area: 53 acres
Note: Recommended for potential development by 1980

5. Wapwallopen

Type: Recreation and Fish Habitat
Location: 2 miles southeast of Wapwallopen, PA.
Drainage Area: 51 sq. miles
Storage: 39,000 ac-ft
Surface Area: 1,000 acres
Note: Recommended for potential development by 2000

SECTION 5

1. Berwick

Type: Low Channel Dam
Location: 4 miles upstream of Berwick, PA.
Drainage Area: No Data
Storage: No Data
Surface Area: 1,250 acres
Note: Recommended for potential development by 1980

2. Beaver Run

Type: Recreation and Fish Habitat
Location: 3 miles east of Schmans, PA.
Drainage Area: 2.3 sq. miles
Storage: 1350 ac-ft
Surface Area: 180 acres
Note: Recommended for potential development by 1980

3. Green Creek

Type: Recreation and Fish Habitat
Location: 9 miles northeast of Bloomsburg, PA.
Drainage Area: 31.3 sq. miles
Storage: 22,400 ac-ft
Surface Area: 1,100 acres
Note: Recommended for potential development by 1980

4. Briar Creek

Type: Wild Life Development
Location: 2 miles north of Berwick, PA.
Drainage Area: 0.7 sq. miles
Storage: 375 ac-ft
Surface Area: 88 acres
Note: Recommended for potential development by 1980

5. Jonestown

Type: Recreation and Fish Habitat
Location: 5 miles above mouth of Huntingdon Creek
Drainage Area: 82 sq. miles
Storage: 62,300 ac-ft
Surface Area: 1,500 acres
Note: Recommended for potential development by 2020

B. U.S. Army Corps of Engineers. September 1986. Chesapeake Bay and Tributaries Reallocation Study - Final Limited Reconnaissance Report.

SECTION 1

1. Towanda

Type: Multipurpose
Location: near Towanda, PA.
Max. Storage: 89,057 ac-ft
Low Flow Augmentation Storage Available: 58,600 ac-ft

C. U.S. Dept. of Agriculture, 1977, Pennsylvania Analytical Summary - Inventory of Potential Upstream Reservoir Sites, Appendix 1.

SECTION 1

1. Tributary South Branch Towanda Creek

Site Number: 40-2
Drainage Area: 1.7 square miles
Storage: 1,220 acre-feet
Surface Area: 52 acres

2. South Branch Towanda Creek

Site No.: 40-3
Drainage Area: 9.1 sq. miles
Storage: 6,150 ac-ft
Surface Area: 305 acres

3. Tributary South Branch Towanda Creek

Site No.: 40-4
Drainage Area: 2.5 sq. miles
Storage: 1,480 ac-ft
Surface Area: 82 acres

4. Tributary South Branch Towanda Creek

Site No.: 40-5
Drainage Area: 2.5 sq. miles
Storage: 800 ac-ft
Surface Area: 55 acres

5. North Branch Towanda Creek

Site No.: 40-7
Drainage Area: 16.7 sq. miles
Storage: 3,030 ac-ft
Surface Area: 190 acres

6. Sugar Creek

Site No.: 40-8
Drainage Area: 49.8 sq. miles
Storage: 3,700 ac-ft
Surface Area: 230 acres

7. Brace Creek

Site No.: 40-10
Drainage Area: 10 sq. miles
Storage: 2,410 ac-ft
Surface Area: 162 acres

8. Peas Creek

Site No.: 41-1
Drainage Area: 11.4 sq. miles
Storage: 7,220 ac-ft
Surface Area: 231 acres

9. West Branch Tomjack Creek

Site No.: 41-2
Drainage Area: 10.6 sq. miles
Storage: 6,900 ac-ft
Surface Area: 150 acres

10. Mud Creek

Site No.: 41-4
Drainage Area: 4.3 sq. miles
Storage: 2,660 ac-ft
Surface Area: 105 acres

11. Sugar Creek

Site No.: 41-8
Drainage Area: 2 sq. miles
Storage: 1,380 ac-ft
Surface Area: 97 acres

12. Tributary North Branch Sugar Creek

Site No.: 41-9
Drainage Area: 8.8 sq. miles
Storage: 6,260 ac-ft
Surface Area: 270 acres

13. Brace Creek

Site No.: 41-10
Drainage Area: 2.6 sq. miles
Storage: 1,650 ac-ft
Surface Area: 115 acres

14. Leonard Creek

Site No.: 41-11
Drainage Area: 2.5 sq. miles
Storage: 1,350 ac-ft
Surface Area: 78 acres

15. Tributary Wyalusing Creek

Site No.: 39-1
Drainage Area: 5.1 sq. miles
Storage: 3,200 ac-ft
Surface Area: 78 acres

16. Middle Branch Creek

Site No.: 39-3
Drainage Area: 22.7 sq. miles
Storage: 4,700 ac-ft
Surface Area: 225 acres

17. Gaylord Creek

Site No.: 39-4
Drainage Area: 15.2 sq. miles
Storage: 3,300 ac-ft
Surface Area: 175 acres

18. Deer Lick Creek

Site No.: 39-11
Drainage Area: 4.8 sq. miles
Storage: 2,050 ac-ft
Surface Area: 130 acres

19. Tributary Sugar Run

Site No.: 09-1
Drainage Area: 4.8 sq. miles
Storage: 3,329 ac-ft
Surface Area: 185 acres

20. Little Tuscarora Creek

Site No.: 010-10
Drainage Area: 3.2 sq. miles
Storage: 884 ac-ft
Surface Area: 66 acres

21. Mill Creek

Site No.: 010-18
Drainage Area: 22.7 sq. miles
Storage: 2,748 ac-ft
Surface Area: 136 acres

22. Vought Creek

Site No.: 011-3
Drainage Area: 1.7 sq. miles
Storage: 1,159 ac-ft
Surface Area: 50 acres

23. Johnson Creek

Site No.: 011-4
Drainage Area: 12.1 sq. miles
Storage: 3,232 ac-ft
Surface Area: 141 acres

24. Bullard Creek

Site No.: 011-6
Drainage Area: 3.2 sq. miles
Storage: 1,122 ac-ft
Surface Area: 67 acres

25. Wilson Creek

Site No.: 011-7
Drainage Area: 10.5 sq. miles
Storage: 1,778 ac-ft
Surface Area: 74 acres

SECTION 2

1. Tunkhannock Creek

Site No.: 38-5
Drainage Area: 37.3 sq. miles
Storage: 14,980 ac-ft
Surface Area: 410 acres

2. East Branch Tunkhannock Creek

Site No.: 38-6
Drainage Area: 9.1 sq. miles
Storage: 1,809 acre-ft
Surface Area: 74 acres

3. East Branch Tunkhannock Creek

Site No.: 38-9
Drainage Area: 21.7 sq. miles
Storage: 3,901 ac-ft
Surface Area: 155 acres

4. Idlewild Creek

Site No.: 38-11
Drainage Area: 7.8 sq. miles
Storage: 5,410 ac-ft
Surface Area: 111 acres

5. Horton Creek

Site No.: 38-16
Drainage Area: 2.1 sq. miles
Storage: 1,456 ac-ft
Surface Area: 87 acres

6. Kern Glen Creek

Site No.: 38-17
Drainage Area: 1.7 sq. miles
Storage: 1,179 ac-ft
Surface Area: 96 acres

7. Billings Mill Brook

Site No.: 38-18
Drainage Area: 0.9 sq. miles
Storage: 624 ac-ft
Surface Area: 56 acres

8. Martins Creek

Site No.: PA467
Drainage Area: 0.8 sq. miles
Storage: 132 ac-ft
Surface Area: 7 acres

9. Tributary Hopbottom Creek

Site No.: PA468
Drainage Area: 0.4 sq. miles
Storage: 49 ac-ft
Surface Area: 4 acres

10. Thomas Creek

Site No.: 010-1
Drainage Area: 48.6 sq. miles
Storage: 4,190 ac-ft
Surface Area: 223 acres

11. Meshoppen Creek

Site No.: 010-2
Drainage Area: 31.8 sq. miles
Storage: 4,964 ac-ft
Surface Area: 483 acres

12. Tributary Nick Creek

Site No.: 010-7
Drainage Area: 2.1 sq. miles
Storage: 1,456 ac-ft
Surface Area: 95 acres

13. Tributary Gardner Creek

Site No.: 010-11
Drainage Area: 1.5 sq. miles
Storage: 1,040 ac-ft
Surface Area: 90 acres

14. Gardner Creek

Site No.: 010-12
Drainage Area: 9.3 sq. miles
Storage: 2,903 ac-ft
Surface Area: 120 acres

15. Buttermilk Creek

Site No.: 010-13
Drainage Area: 2.4 sq. miles
Storage: 616 ac-ft
Surface Area: 86 acres

16. Buttermilk Creek

Site No.: 010-14
Drainage Area: 1.1 sq. miles
Storage: 763 ac-ft
Surface Area: 67 acres

17. Tributary Meshoppen Creek

Site No.: 010-3
Drainage Area: 2.4 sq. miles
Storage: 684 ac-ft
Surface Area: 53 acres

SECTION 3

1. East Branch Roaring Brook

Site No.: 37-9
Drainage Area: 5.2 sq. miles
Storage: 4,300 ac-ft
Surface Area: 310 acres

2. Tributary Lackawanna River

Site No.: 37-15
Drainage Area: 1.7 sq. miles
Storage: 1,370 ac-ft
Surface Area: 84 acres

3. Lackawanna River

Site No.: 37-16
Drainage Area: 6.4 sq. miles
Storage: 5,100 ac-ft
Surface Area: 300 acres

SECTION 4

1. Wapwallopen Creek

Site No.: 07-2
Drainage Area: 6 sq. miles
Storage: 2,183 ac-ft
Surface Area: 150 acres

2. Tributary Wapwallopen Creek

Site No.: 07-3A
Drainage Area: 33.4 sq. miles
Storage: 6,745 ac-ft
Surface Area: 200 acres

3. Little Wapwallopen Creek

Site No.: 07-6
Drainage Area: 1.7 sq. miles
Storage: 1,239 ac-ft
Surface Area: 105 acres

4. Little Wapwallopen Creek

Site No.: 07-8
Drainage Area: 24 sq. miles
Storage: 5,078 ac-ft
Surface Area: 216 acres

5. Tributary Pond Creek

Site No.: 07-11
Drainage Area: 1.4 sq. miles
Storage: 1,015 ac-ft
Surface Area: 195 acres

6. Abraham Creek

Site No.: 08-1
Drainage Area: 1.8 sq. miles
Storage: 1,246 ac-ft
Surface Area: 103 acres

7. Tributary Spring Run

Site No.: 08-3
Drainage Area: 11.7 sq. miles
Storage: 2,735 ac-ft
Surface Area: 175 acres

8. Tributary Harvey Creek

Site No.: 08-5
Drainage Area: 2.2 sq. miles
Storage: 1,542 ac-ft
Surface Area: 103 acres

9. Roaring Brook

Site No.: 08-6
Drainage Area: 1.5 sq. miles
Storage: 1,052 ac-ft
Surface Area: 102 acres

10. Tributary Shickshinny Creek

Site No.: 08-8
Drainage Area: 2.6 sq. miles
Storage: 1,823 ac-ft
Surface Area: 96 acres

11. Little Shickshinny Creek

Site No.: 08-10
Drainage Area: 3.2 sq. miles
Storage: 2,236 ac-ft
Surface Area: 165 acres

SECTION 5

1. Huntington Creek

Site No.: 36-4A
Drainage Area: 9.1 sq. miles
Storage: 5,030 ac-ft
Surface Area: 158 acres

2. Marsh Creek

Site No.: 36-5
Drainage Area: 2.2 sq. miles
Storage: 1,706 ac-ft
Surface Area: 135 acres

3. Tributary Huntington Creek

Site No.: 36-6
Drainage Area: 1.4 sq. miles
Storage: 1,190 ac-ft
Surface Area: 180 acres

4. Huntington Creek

Site No.: 36-7A
Drainage Area: 73.1 sq. miles
Storage: 16,300 ac-ft
Surface Area: 760 acres

5. Pine Creek

Site No.: 36-8
Drainage Area: 13.5 sq. miles
Storage: 13,790 ac-ft
Surface Area: 480 acres

6. Pine Creek

Site No.: 36-9
Drainage Area: 10.3 sq. miles
Storage: 2,990 ac-ft
Surface Area: 245 acres

7. Maple Run Creek

Site No.: 36-10
Drainage Area: 3 sq. miles
Storage: 2,560 ac-ft
Surface Area: 196 acres

8. Little Fishing Creek

Site No.: 36-12
Drainage Area: 11.7 sq. miles
Storage: 7,000 ac-ft
Surface Area: 225 acres

9. Tributary Nescopeck Creek

Site No.: 35-1
Drainage Area: 1 sq. mile
Storage: 770 ac-ft
Surface Area: 70 acres

10. Nescopeck Creek

Site No.: 35-4
Drainage Area: 6.9 sq. miles
Storage: 5,280 ac-ft
Surface Area: 255 acres

11. Little Nescopeck Creek

Site No.: 35-5
Drainage Area: 3.9 sq. miles
Storage: 1,190 ac-ft
Surface Area: 80 acres

12. Tenmile Run

Site No.: 07-1
Drainage Area: 7.7 sq. miles
Storage: 3,236 ac-ft
Surface Area: 225 acres

13. West Branch Briar Creek

Site No.: 08-11
Drainage Area: 5.5 sq. miles
Storage: 1,700 ac-ft
Surface Area: 145 acres

14. East Branch Briar Creek

Site No.: PA497
Drainage Area: 5.1 sq. miles
Storage: 1,010 ac-ft
Surface Area: 85 acres

15. Glen Brook

Site No.: PA498
Drainage Area: 2.6 sq. miles
Storage: 292 ac-ft
Surface Area: 21 acres

16. Nescopeck Creek

Site No.: PA665
Drainage Area: 33.2 sq. miles
Storage: 19,593 ac-ft
Surface Area: 920 acres

17. Tributary Catawissa Creek

Site No.: 34-1
Drainage Area: 3.7 sq. miles
Storage: 2,900 ac-ft
Surface Area: 128 acres

18. Scotch Run

Site No.: 34-2
Drainage Area: 6 sq. miles
Storage: 4,920 ac-ft
Surface Area: 180 acres

19. Tomhicken Creek

Site No.: 34-4
Drainage Area: 17.3 sq. miles
Storage: 5,785 ac-ft
Surface Area: 196 acres

20. Tributary Little Catawissa Creek

Site No.: 34-5
Drainage Area: 6 sq. miles
Storage: 4,600 ac-ft
Surface Area: 200 acres

21. Tributary Roaring Creek

Site No.: 06-6
Drainage Area: 4.7 sq. miles
Storage: 3,324 ac-ft
Surface Area: 130 acres

22. Lick Run

Site No.: 06-7
Drainage Area: 2.1 sq. miles
Storage: 1,615 ac-ft
Surface Area: 126 acres

23. Mugser Run

Site No.: 06-8
Drainage Area: 4.5 sq. miles
Storage: 3,461 ac-ft
Surface Area: 167 acres

24. Tributary Susquehanna River

Site No.: 019-1
Drainage Area: 3.9 sq. miles
Storage: 3,237 ac-ft
Surface Area: 155 acres

APPENDIX C

AGRICULTURAL WATER USE DATA

TABLE C-1

BRADFORD COUNTY, PA. LIVESTOCK

Parameter	1982	1978	1974	1969	1964
Livestock Numbers*	97054	213441	319584	283266	251877
Milk Cows	38567	37309	38905	35187	44415
Other Cattle & Calves	49113	38546	38023	30243	29948
Swine	3320	3053	1391	1329	9211
Sheep & Lambs	4916	4100	3343	4389	4752
Horses	1065	1031	819	1507	?
Turkeys	73	237	42	51	1214
Chickens	?	129165	237061	210560	162337
Livestock Water Use (gpd)	1592754	1442775	1473712	1295056	1540102
Milk Cows (25)	964175	932725	972625	879675	1110375
Other Cattle & Calves (12)	589356	462552	456276	362916	359376
Swine (5.0)	16600	15265	6955	6645	46055
Sheep & Lambs (2.0)	9832	8200	6686	8778	9504
Horses (12)	12780	12372	9828	18084	?
Turkeys (0.15)	11	36	6	8	182
Chickens (0.09)	?	11625	21336	18950	14610
Livestock Consumptive Use (gpd)**	1194566	1082081	1105284	971292	1155077

* 1969 and 1974 data for turkeys and 1964 data for chickens include only farms with sales of $2,500 and over.

** Consumptive use was assumed to be 75% of total use.

Source: Derived from U.S. Department of Commerce (1969, 1974, 1978, & 1982).

TABLE C-2

COLUMBIA COUNTY, PA. LIVESTOCK

Parameter	1982	1978	1974	1969	1964
Livestock Numbers*	74544	97822	124639	326556	512041
Milk Cows	4457	4113	4408	5721	7127
Other Cattle & Calves	9486	9352	11959	10802	10280
Swine	8039	10098	8815	9404	8430
Sheep & Lambs	824	1044	780	989	800
Horses	512	563	415	436	?
Turkeys	171	538	4555	1199	250
Chickens	51055	72114	93707	298005	490154
Livestock Water Use (gpd)	277865	280954	313440	353880	389432
Milk Cows (25)	111425	102825	110200	143025	178175
Other Cattle & Calves (12)	113832	112224	143508	129624	123360
Swine (5.0)	40195	50490	44075	47020	42150
Sheep & Lambs (2.0)	1648	2088	1560	1978	1600
Horses (12)	6144	6756	4980	5232	?
Turkeys (0.15)	26	81	683	180	38
Chickens (0.09)	4595	6490	8434	26821	44114
Livestock Consumptive Use (gpd)**	208399	210716	235080	265410	292078

* 1969 and 1974 data for turkeys and 1964 data for chickens include only farms with sales of $2,500 and over.

** Consumptive use was assumed to be 75% of total use.

Source: Derived from U.S. Department of Commerce (1969, 1974, 1978, & 1982).

TABLE C-3

LACKAWANNA COUNTY, PA. LIVESTOCK

Parameter	1982	1978	1974	1969	1964
Livestock Numbers*	14133	10040	103602	171756	214110
Milk Cows	3586	3605	4141	5893	8165
Other Cattle & Calves	5168	4887	5538	5221	5637
Swine	1213	801	845	246	1087
Sheep & Lambs	207	481	14	406	28
Horses	414	266	258	341	?
Turkeys	43	?	3	--	--
Chickens	3502	?	92803	159649	199193
Livestock Water Use (gpd)	163435	156928	185683	230479	295187
Milk Cows (25)	89650	90125	103525	147325	204125
Other Cattle & Calves (12)	62016	58644	66456	62652	67644
Swine (5.0)	6065	4005	4225	1230	5435
Sheep & Lambs (2.0)	414	962	28	812	56
Horses (12)	4968	3192	3096	4092	?
Turkeys (0.15)	7	?	1	?	?
Chickens (0.09)	315	?	8352	14368	17927
Livestock Consumptive Use (gpd)**	122576	117696	139262	172859	221390

* 1969 and 1974 data for turkeys and 1964 data for chickens include only farms with sales of $2,500 and over.

** Consumptive use was assumed to be 75% of total use.

Source: Derived from U.S. Department of Commerce (1969, 1974, 1978, & 1982).

TABLE C-4

LUZERNE COUNTY, PA. LIVESTOCK

Parameter	1982	1978	1974	1969	1964
Livestock Numbers*	126341	73718	92464	78550	192091
Milk Cows	3466	3483	4389	4650	6552
Other Cattle & Calves	5557	4344	5008	4545	5567
Swine	2279	3066	1251	2295	2683
Sheep & Lambs	558	282	572	594	1490
Horses	318	236	215	344	?
Turkeys	126	96	70	?	100
Chickens	114037	62211	80959	66122	175699
Livestock Water Use (gpd)	179944	163542	187097	193532	262827
Milk Cows (25)	86650	87075	109725	116250	163800
Other Cattle & Calves (12)	66684	52128	60096	54540	66804
Swine (5.0)	11396	15330	6255	11475	13415
Sheep & Lambs (2.0)	1116	564	1144	1188	2980
Horses (12)	3816	2832	2580	4128	?
Turkeys (0.15)	19	14	11	?	15
Chickens (0.09)	10263	5599	7286	5251	15813
Livestock Consumptive Use (gpd)**	134958	122657	140323	145149	197120

* 1969 and 1974 data for turkeys and 1964 data for chickens include only farms with sales of $2,500 and over.

** Consumptive use was assumed to be 75% of total use.

Source: Derived from U.S. Department of Commerce (1969, 1974, 1978, & 1982).

TABLE C-5

MONTOUR COUNTY, PA. LIVESTOCK

Parameter	1982	1978	1974	1969	1964
Livestock Numbers*	16129	15638	32240	20180	67289
Milk Cows	2299	2374	2062	2410	2870
Other Cattle & Calves	4615	5459	4389	3988	4302
Swine	8668	7202	3942	2440	4250
Sheep & Lambs	228	169	269	534	171
Horses	281	362	194	168	?
Turkeys	38	72	0	57	?
Chickens	?	?	21384	10783	55687
Livestock Water Use (gpd)	160029	165561	128719	123970	150023
Milk Cows (25)	57475	59350	51550	60250	71750
Other Cattle & Calves (12)	55380	65508	52668	47856	51624
Swine (5.0)	43340	36010	19710	12200	21295
Sheep & Lambs (2.0)	456	338	538	668	342
Horses (12)	3372	4344	2328	2016	?
Turkeys (0.15)	6	11	0	9	?
Chickens (0.09)	?	?	1925	971	5012
Livestock Consumptive Use (gpd)**	120022	124171	96539	92978	112517

* 1969 and 1974 data for turkeys and 1964 data for chickens include only farms with sales of $2,500 and over.

** Consumptive use was assumed to be 75% of total use.

Source: Derived from U.S. Department of Commerce (1969, 1974, 1978, & 1982).

TABLE C-6

SUSQUEHANNA COUNTY, PA. LIVESTOCK

Parameter	1982	1978	1974	1969	1964
Livestock Numbers*	70365	193580	274164	86624	147385
Milk Cows	21907	22777	24129	25691	30386
Other Cattle & Calves	20827	19210	21424	21057	21761
Swine	1466	1577	449	502	373
Sheep & Lambs	1749	1839	3097	3114	2226
Horses	599	679	667	639	?
Turkeys	?	106	100	1402	250
Chickens	23817	147392	224298	34219	92389
Livestock Water Use (gpd)	817759	832937	896958	914655	1035533
Milk Cows (25)	547675	569425	603225	642275	759650
Other Cattle & Calves (12)	249924	230520	257088	252684	261132
Swine (5.0)	7330	7885	2245	2510	1865
Sheep & Lambs (2.0)	3498	3678	6194	6228	4452
Horses (12)	7188	8148	8004	7668	?
Turkeys (0.15)	?	16	15	210	38
Chickens (0.09)	2144	13265	20187	3080	8396
Livestock Consumptive Use (gpd)**	613319	624703	672719	685991	776650

* 1969 and 1974 data for turkeys and 1964 data for chickens include only farms with sales of $2,500 and over.

** Consumptive use was assumed to be 75% of total use.

Source: Derived from U.S. Department of Commerce (1969, 1974, 1978, & 1982).

TABLE C-7

WYOMING COUNTY, PA. LIVESTOCK

Parameter	1982	1978	1974	1969	1964
Livestock Numbers*	17541	57470	56269	64962	90964
Milk Cows	7705	7649	9078	8995	10941
Other Cattle & Calves	7816	7255	9319	7069	7307
Swine	1086	1384	436	110	467
Sheep & Lambs	627	630	423	423	528
Horses	292	261	330	263	?
Turkeys	15	37	8	3	--
Chickens	?	40354	36675	48099	71721
Livestock Water Use (gpd)	296607	293226	348991	318585	371055
Milk Cows (25)	192625	191225	226875	224875	273525
Other Cattle & Calves (12)	93792	87060	111828	84828	87684
Swine (5.0)	5430	6920	2180	550	2335
Sheep & Lambs (2.0)	1254	1260	846	846	1056
Horses (12)	3504	3132	3960	3156	?
Turkeys (0.15)	2	6	1	1	?
Chickens (0.09)	?	3623	3301	4329	6455
Livestock Consumptive Use (gpd)**	222455	219920	261743	238939	278291

* 1969 and 1974 data for turkeys and 1964 data for chickens include only farms with sales of $2,500 and over.

** Consumptive use was assumed to be 75% of total use.

Source: Derived from U.S. Department of Commerce (1969, 1974, 1978, & 1982).

TABLE C-8

BRADFORD COUNTY, PA. IRRIGATION

Parameter	1982	1978	1974	1969	1964
Approx. Area of County (Acres)*	737350	737350	734656	734656	734080
Proportion of Area in Farms	48	50.6	48.6	51.8	63.5
Land in Farms (Acres)	353710	373150	357314	380291	465896
Total Cropland	205280	218675	203955	207616	
Total Woodland	93712	98434	90367	94110	123970
Other Land	54718	56041	62722	78565	29689
Total Cropland (Acres)	205280	218675	203955	207616	
Harvested Cropland	154544	154221	138461	127396	164019
Land Used Only for Pasture	41549	52617	52501	58106	38744
Other Cropland	9187	11837	12993	22114	19726
No. Farms with Irrigated Land	8	5	9	6	9
Irrigated Land (Acres)	26	39	90	11	40
Harvested Cropland**	26	39	90	9	35
Pastureland & Other**	--	--	--	--	5
Irrigation Water Used (gpd)	50429	75643	174560	21335	77582
Irrigation Consumption (gpd)	42865	64297	148376	18135	65945

* Individual farms were considered either entirely in or out of county.
** 1969 and 1974 data include only farms with sales of $2,500 and over.

Source: Derived from U.S. Department of Commerce (1969, 1974, 1978, and 1982).

TABLE C-9

COLUMBIA COUNTY, PA. IRRIGATION

Parameter	1982	1978	1974	1969	1964
Approx. Area of County (Acres)*	310988	310988	309760	309760	309760
Proportion of Area in Farms	39.4	42.1	42.3	45.8	49.5
Land in Farms (Acres)	122598	130951	130941	141962	170068
Total Cropland	86187	90275	85789	88513	
Total Woodland	27317	30613	31000	36092	40803
Other Land	9094	10063	14152	17357	10188
Total Cropland (Acres)	86187	90275	85789	88513	
Harvested Cropland	72476	70390	63733	56400	69262
Land Used Only for Pasture	6142	8754	9167	9021	6192
Other Cropland	7569	11131	12889	23092	20504
No. Farms with Irrigated Land	27	20	19	17	24
Irrigated Land (Acres)	344	313	311	535	295
Harvested Cropland**	?	309	311	535	270
Pastureland & Other**	?	4	--	--	25
Irrigation Water Used (gpd)	667209	607082	603203	1037665	572170
Irrigation Consumption (gpd)	567128	516020	512723	882015	486345

* Individual farms were considered either entirely in or out of county.
** 1969 and 1974 data include only farms with sales of $2,500 and over.

Source: Derived from U.S. Department of Commerce (1969, 1974, 1978, and 1982).

TABLE C-10

LACKAWANNA COUNTY, PA. IRRIGATION

Parameter	1982	1978	1974	1969	1964
Approx. Area of County (Acres)*	295104	295104	290624	290624	290560
Proportion of Area in Farms	16.2	16.4	16.3	18.5	24.8
Land in Farms (Acres)	47718	48533	47441	53747	87899
Total Cropland	28173	28927	28687	30627	
Total Woodland	11779	13590	10814	13981	19071
Other Land	7766	6016	7940	9139	4059
Total Cropland (Acres)	28173	28927	28687	30627	
Harvested Cropland	21184	20658	18516	18577	31811
Land Used Only for Pasture	4550	6055	7537	9714	6561
Other Cropland	2439	2214	2634	2336	4190
No. Farms with Irrigated Land	3	4	1	--	6
Irrigated Land (Acres)	5	4	1	--	100
Harvested Cropland**	5	4	1	--	94
Pastureland & Other**	--	--	--	--	6
Irrigation Water Used (gpd)	9698	7758	1940	--	193956
Irrigation Consumption (gpd)	8243	6594	1649	--	164863

* Individual farms were considered either entirely in or out of county.
** 1969 and 1974 data include only farms with sales of $2,500 and over.

Source: Derived from U.S. Department of Commerce (1969, 1974, 1978, and 1982).

TABLE C-11

LUZERNE COUNTY, PA. IRRIGATION

Parameter	1982	1978	1974	1969	1964
Approx. Area of County (Acres)*	570220	570220	567040	567040	570240
Proportion of Area in Farms	11.8	11.6	11.3	13.3	17.4
Land in Farms (Acres)	67345	66034	64245	75652	99226
Total Cropland	44489	43606	40424	44406	
Total Woodland	16221	16504	17903	22988	31087
Other Land	6635	5924	5918	8258	8315
Total Cropland (Acres)	44489	43606	40424	44406	
Harvested Cropland	35622	32066	29898	28243	38106
Land Used Only for Pasture	3664	5297	5477	7097	6440
Other Cropland	5203	6243	5044	9066	10232
No. Farms with Irrigated Land	30	26	16	12	24
Irrigated Land (Acres)	404	357	363	291	608
Harvested Cropland**	404	331	363	291	585
Pastureland & Other**	--	26	--	--	15
Irrigation Water Used (gpd)	783582	692423	704060	564412	1179252
Irrigation Consumption (gpd)	666041	588560	598451	479750	1002364

* Individual farms were considered either entirely in or out of county.
** 1969 and 1974 data include only farms with sales of $2,500 and over.

Source: Derived from U.S. Department of Commerce (1969, 1974, 1978, and 1982).

TABLE C-12

MONTOUR COUNTY, PA. IRRIGATION

Parameter	1982	1978	1974	1969	1964
Approx. Area of County (Acres)*	83852	832 00	82944	82944	83200
Proportion of Area in Farms	58.2	66.2	56.8	60.7	68.5
Land in Farms (Acres)	48815	55225	47092	50368	57019
Total Cropland	38897	41237	35593	36915	39778
Total Woodland	6983	9888	7013	7875	11161
Other Land	2935	4000	4486	5578	6079
Total Cropland (Acres)	38897	41233	35593	36915	39778
Harvested Cropland	31638	32563	28195	23181	29520
Land Used Only for Pasture	2326	3472	3193	3352	2524
Other Cropland	4933	5202	4205	10382	7734
No. Farms with Irrigated Land	1	3	5	3	2
Irrigated Land (Acres)	?	6	17	68	8
Harvested Cropland**	?	6	17	68	?
Pastureland & Other**	--	--	0	0	?
Irrigation Water Used (gpd)	?	11637	32973	131890	15517
Irrigation Consumption (gpd)	?	9892	28027	112107	13190

* Individual farms were considered either entirely in or out of county.
** 1969 and 1974 data include only farms with sales of $2,500 and over.

Source: Derived from U.S. Department of Commerce (1969, 1974, 1978, and 1982).

TABLE C-13

SUSQUEHANNA COUNTY, PA. IRRIGATION

Parameter	1982	1978	1974	1969	1964
Approx. Area of County (Acres)*	528614	528614	533120	533120	535040
Proportion of Area in Farms	41.0	44.9	42.8	50.4	58.9
Land in Farms (Acres)	216557	237523	227959	268621	315370
Total Cropland	109096	121341	109228	122371	
Total Woodland	66350	75528	71817	86491	98043
Other Land	41111	40654	46914	59759	19875
Total Cropland (Acres)	109096	121341	109228	122371	
Harvested Cropland	74010	79557	69264	70564	97898
Land Used Only for Pasture	29693	36034	34240	41400	19238
Other Cropland	5393	5745	5724	10407	11775
No. Farms with Irrigated Land	3	7	3	1	3
Irrigated Land (Acres)	27	356	1073	11	60
Harvested Cropland**	27	--	1073	11	5
Pastureland & Other**	--	--	--	--	55
Irrigation Water Used (gpd)	52368	690483	2081148	21335	116374
Irrigation Consumption (gpd)	44513	586911	1768976	18135	98918

* Individual farms were considered either entirely in or out of county.
** 1969 and 1974 data include only farms with sales of $2,500 and over.

Source: Derived from U.S. Department of Commerce (1969, 1974, 1978, and 1982).

TABLE C-14

WYOMING COUNTY, PA. IRRIGATION

Parameter	1982	1978	1974	1969	1964
Approx. Area of County (Acres)*	255609	255609	254528	254528	253440
Proportion of Area in Farms	30.4	32.3	33.3	33.6	42.0
Land in Farms (Acres)	77606	82584	84809	85454	106542
Total Cropland	41185	43324	45148	41243	
Total Woodland	27328	26715	26974	29817	38487
Other Land	9093	12545	12687	14485	4291
Total Cropland (Acres)	41185	43324	45148	41243	
Harvested Cropland	30493	30282	29979	24976	32958
Land Used Only for Pasture	8052	9913	12657	10879	7396
Other Cropland	2640	3129	2512	5388	4818
No. Farms with Irrigated Land	7	4	2	2	7
Irrigated Land (Acres)	113	--	18	105	236
Harvested Cropland**	113	--	18	105	236
Pastureland & Other**	--	--	--	--	--
Irrigation Water Used (gpd)	219170	--	34912	203654	457736
Irrigation Consumption (gpd)	186295	--	29675	173106	389076

* Individual farms were considered either entirely in or out of county.
** 1969 and 1974 data include only farms with sales of $2,500 and over.

Source: Derived from U.S. Department of Commerce (1969, 1974, 1978, and 1982).

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